October 1, 1993 - September 30, 1994

'94 Adaptive COPE Annual Report

Adaptive COPE Program - Hatfield Marine Science Center - 2030 S. Marine Science Drive - Oregon State University - Newport, OR 97365-5296 - (503) 867-0220

Coastal Oregon Productivity Enhancement
COPE PROGRAM

Initiated in 1986, the Coastal Oregon Productivity Enhancement (COPE) Program is a cooperative effort among the College of Forestry at Oregon State University (OSU), the USDA Forest Service Pacific Northwest Research Station (PNW), the USDI Bureau of Land Management (BLM), other federal and state agencies, forest industry, county governments, and the Oregon Small Woodlands Association. The intent of the program is to provide resource managers and the public with information on management of fish, timber, water, wildlife, and other resources of the Oregon Coast Range. To find effective ways to manage these diverse resources collectively, the COPE Program integrates research, education, and scientific disciplines.

The COPE Program has two related components; scientists in both Fundamental COPE and Adaptive COPE focus on problems related to riparian-zone management and the regeneration of Oregon Coast Range forests. Fundamental COPE scientists, mainly from OSU and the USDA Pacific Northwest Research Station in Corvallis, conduct basic research studies. This research is supported by the USDA Forest Service and by the USDI Bureau of Land Management through the USDI research agency, the National Biological Survey. Adaptive COPE, an interdisciplinary team of OSU College of Forestry scientists, applies and adapts existing research to Oregon Coast Range conditions. Stationed in Newport at the Hatfield Marine Science Center, the Adaptive COPE team also facilitates information transfer by providing continuing-education opportunities. Adaptive COPE scientists work with county Forestry Extension agents to extend the program throughout the 13-county area of the Oregon Coast Range. The Adaptive COPE Program is funded by 33 organizations, including federal and state agencies, forest industries, county and city governments, and the Oregon Small Woodlands Association.

COPE ORGANIZATION

Advisory Council
Representatives of COPE Cooperators
Provides advice and guidance on program direction
(listing on inside back cover)

Dean, College of Forestry
George W. Brown
Convenes Advisory Council
Makes major decisions on OSU support

Director, PNW Station
Charles Philpot
Makes major decisions on PNW support

COPE Program Manager
Stephen D. Hobbs
Coordinates activities of all organizations involved and provides overall program leadership and administration

Adaptive COPE
OSU College of Forestry scientists
Conducts adaptive research and facilitates transfer of information

Fundamental COPE
OSU and PNW scientists
Conducts basic research

Adaptive COPE Staff

Scientists

Forest Engineering
Soil Science/Hydrology: Arne Skaugset

Forest Science
Wildlife: John P. Hayes
Silviculture: William H. Emmingham

Office Coordinator: Skye Etessami

Research Support
Michael Adam
Doug Bateman
Elizabeth Dent
Eric Horvath
Pat Hounihan
Kathleen Maas
Vanessa Stone
Nobuya Suzuki
Jennifer Weeks

COOPERATORS

Federal Agencies

Bureau of Indian Affairs
National Biological Survey/Bureau of Land Management
Pacific Northwest Research Station
Siskiyou National Forest
Siuslaw National Forest
U.S. Fish and Wildlife Service

State Agencies

Department of Fish and Wildlife
Department of Forestry
Oregon State University

Oregon Counties

Benton
Coos
Curry
Douglas
Josephine
Lincoln
Polk
Washington

Forest Industries

Boise Cascade Corporation
Georgia-Pacific Corporation
Giustina Land & Timber Company
Hydraulic & Machine Services, Incorporated
Longview Fibre Company
Menasha Corporation
Rosboro Lumber Company
Roseburg Resources Company
Smurfit Newsprint Corporation
Starker Forests, Incorporated
Stimson Lumber Company
Weyerhaeuser Company
Willamette Industries, Incorporated
Willamina Lumber Company

Other

City of Newport
Oregon Small Woodlands Association

Gail Wells, Editor

Cover Photo by Kathleen G. Maas

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HIGHLIGHTS FOR FISCAL YEAR 1994

During its seventh year of research and education activities, Adaptive COPE

- Initiated a major study examining the influence of various commercial-thinning regimes on wildlife populations and habitat in managed stands near Tillamook.

- Initiated a study on the effects of thinning and pruning on forest growth and yield in managed stands near Coos Bay.

- Refined some vegetation-management strategies for getting conifers growing in streamside buffer areas.

- Began a study on the habitat relationships of bats and the influence of forest management activities on bat populations.

- Determined that a forest stream's habitat features can be enhanced by adding large woody debris in the course of logging, and that such an operation can be cost-effective if well planned and carried out.

- Determined that woody debris pieces longer than 2 feet and laid at right angles to the stream bed are best at creating pools for fish.

- Published six papers in scientific journals, proceedings, or books.

- Sponsored a major symposium and field tour on the ecology and management of Coast Range forests, which attracted 250 participants.

- Cosponsored three other workshops, two on silvicultural alternatives and one on ecosystem management.

- Gave 25 presentations to audiences including scientists of several disciplines, forest managers both public and private, small-woodland owners, university faculty, staff, and students, and the public.

- Produced four issues of the *COPE Report* quarterly newsletter highlighting Fundamental and Adaptive COPE research and technology transfer activities. The *COPE Report* reaches more than 2,100 readers.

- Continued to exchange information with cooperators and citizens through informal field tours, office visits, and consultation.

INTRODUCTION

The Coastal Oregon Productivity Enhancement (COPE) Program conducts research on the fisheries, wildlife, timber, water, and soil resources of the Oregon Coast Range. The program's objective is to generate knowledge to help managers maintain and enhance the diversity of temperate coastal forest resources.

The program has two components, Fundamental and Adaptive COPE. The role of Adaptive COPE, whose activities are summarized in this Annual Report, is to develop and adapt research information to address specific multiple-resource and management questions and to transmit that information to those who can use it.

When COPE began in 1986, the pertinent resource issues included the withdrawal of federal lands from the timber base, the decline of fish runs, and increasing public concern for nongame wildlife. Since that time, additional developments, such as the listing of several wildlife species as threatened or endangered and scientists' growing attention to questions of biological diversity, have intensified the need for managers to know more about all these resources.

Several Adaptive COPE studies are already providing valuable information. Two good examples are the study on the habitat characteristics of coastal cutthroat trout (please see report on page 6), and the study on how the placement of large woody debris in forest streams improves fish habitat (please see report on page 22).

A major new study was initiated this year, a large-scale project in wildlife management and silviculture involving young Douglas-fir stands on lands managed by the Oregon Department of Forestry and Stimson Lumber Company in the former Tillamook Burn area. Launching this project called for a major effort from the Adaptive COPE team during the spring and early summer. Two graduate students, Nobuya Suzuki and Jennifer Weeks, were brought on board to help with the project. You'll find information about them and the rest of the Adaptive COPE team on pages 33 and 34.

Adaptive COPE's commitment to outreach gets research results quickly into the hands of on-the-ground managers. This year, we sponsored or cosponsored four workshops, including a major symposium featuring the results of COPE research during the first half of the program (please see page 29). The three-day symposium was well attended—we attracted some 250 participants—and generated a good deal of discussion. All together, almost 500 people attended COPE-sponsored workshops this year.

Adaptive COPE team members also made more than two dozen presentations to a wide range of audiences, including scientists of several disciplines, forest managers from public agencies and private industry, small-woodland owners, university faculty, staff, and students, and the general public.

Finally, we produced four issues of the *COPE Report* and initiated many formal and informal visits with interested people.

RESEARCH

SLOPE STABILITY

MODELING ROOT REINFORCEMENT IN SHALLOW FOREST SOILS

(Arne Skaugset—Adaptive COPE; Marvin Pyles—OSU Department of Forest Engineering)

Landslides are common in the Oregon Coast Range because of the combination of steep slopes, shallow soils, and prolonged and sometimes intense winter rainfall. Historically, road-related landslides have been the dominant source of management-caused erosion. As road construction and maintenance practices have improved, however, road-related landslides have diminished in importance, and the emphasis has shifted to landslides elsewhere in harvest units.

In-unit landslides result, in theory, when the roots of harvested trees decay, reducing soil reinforcement and thus soil strength. The goal of this research is to develop a model to predict the increase in soil strength attributable to root reinforcement. The objectives of this project are 1) to develop a process-based, mechanistic model of root reinforcement in shallow forest soils, and 2) to carry out a parameter study with the model and compare its results with data available in the literature.

The conceptual development of the analytical model was reported in *COPE Report* 2(2):4-7. The concept for the model is based on reinforced-earth theory, with roots treated as reinforcing elements in the soil and modeled mathematically as axially and laterally loaded piles. The differential equations governing the behavior of the reinforcing roots are solved by means of a finite-difference approximation.

The analytical model is fully programmed and functioning. The model is now undergoing a sensitivity analysis or parameter study to determine how it will perform over a range of soil and root properties. The model results will subsequently be compared with values in the technical literature.

This project will help increase our understanding of how roots reinforce shallow forest soils, and will therefore be of value in managing landslide-prone terrain. The model should also be valuable for those interested in investigating the effect of vegetation type and density on the stability of high-risk sites and assessing the effects of alternative silvicultural practices on soil strength. Present slope-stability models that require information on root reinforcement could be improved by incorporating information from this model.

ASSESSING THE STABILITY OF END-HAUL DISPOSAL AREAS

(Clint Davis and Marvin Pyles—OSU Department of Forest Engineering; Arne Skaugset—Adaptive COPE; Dave Michael, Keith Mills, and John Seward—Oregon Department of Forestry; Jerry Richeson—Bureau of Land Management; Bob Young—Siuslaw National Forest)

End-hauling is the practice of loading and hauling road construction spoil from steep terrain to more stable locations. Locating sufficiently flat and stable end-haul disposal sites is a significant problem in the steep, highly dissected terrain of the Coast Range. Recent experience has shown that relatively flat, apparently stable terrain can fail when spoil material is placed on it. The failure rate for end-haul disposal areas is small, but the consequences of failure can be significant. Because this problem has never been rigorously investigated, there are no formal criteria for selecting end-haul disposal sites. The primary objective of this project is to formulate a set of recommendations for identifying stable end-haul disposal sites.

Since last year's *Annual Report*, we have visited approximately 40-45 end-haul disposal sites and have evaluated them for stability criteria such as geologic formations, evidence of or potential for groundwater, slope steepness and height, and quantity and height of the disposal material. Many of those sites were surveyed and soil samples obtained. Nine sites, both failed and unfailed, were analyzed in detail for slope stability. These analyses were supplemented by laboratory analyses of soil strength parameters.

Having now completed the analysis portion of the project, we have found that traditional stability analysis alone, working with limited knowledge of subsurface conditions, does not accurately depict true slope stability in many cases. In general, surface site characteristics, especially ground slope and height of slope below the disposal area, appear to be of primary importance in whether a given site will fail or not. The final report on this project will elaborate on applying these factors in selecting suitable sites for end-haul disposal.

The photographs show graphic contrast between failed and unfailed disposal sites. The large, eroded scarp is at the moderately large, failed Esmond Creek site (Figure 1), which is located on a high, steep slope. By contrast, the much larger Rock Creek site (Figure 2), which is stable, is located on a very large, more gently sloping plateau. Such appropriate sites are difficult to find in the Coast Range.

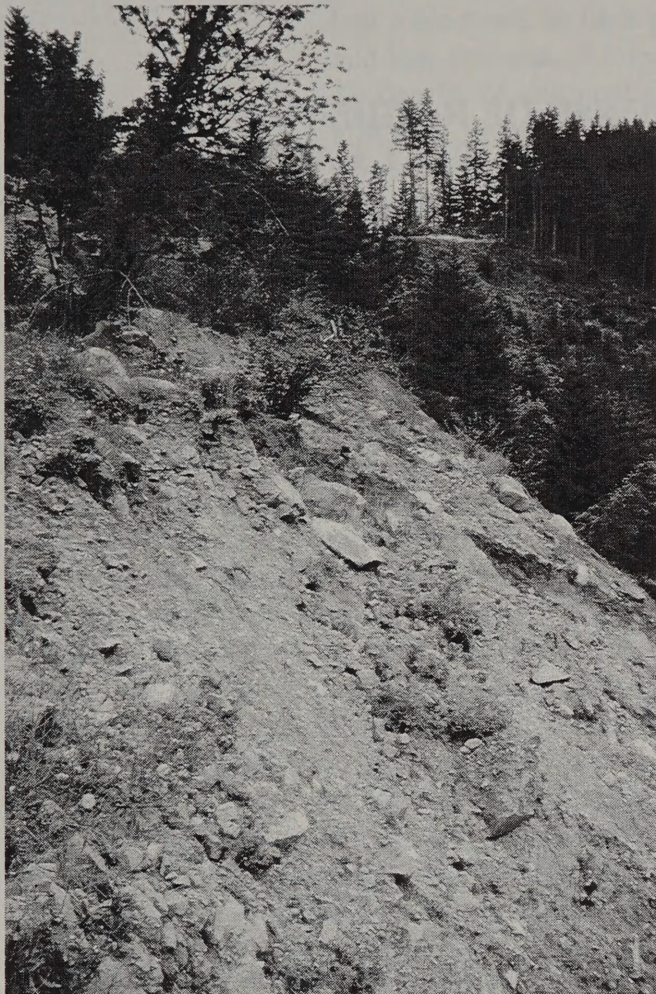

Figure 1. *Esmond Creek site.*

Figure 2. *Rock Creek site.*

LONG-TERM RESPONSE OF RESIDENT COASTAL CUTTHROAT TROUT TO FOREST HARVEST

(Patrick J. Connolly and James D. Hall—OSU Fisheries and Wildlife Department; Arne Skaugset—Adaptive COPE)

The objective of this study is to characterize the status of stream habitat and populations of resident cutthroat trout within Coast Range basins logged 20-60 years ago. The basins chosen for this study were logged before the adoption of Oregon's Forest Practice Act and the first set of forest practice rules in 1972. We recognized that most forests mature enough for a second harvest within the next 30 years were logged before the implementation of the first set of forest practice rules. Current rules dictate that streamside prescriptions will be more rigorous for streams in which a game fish such as cutthroat trout is present. Because the only fish occupying many of the headwater streams in Oregon's Coast Range are cutthroat trout, their presence highly influences current management decisions on degree of stream protection in many of the small basins within the region. If a stream's future potential for supporting a cutthroat trout population is to be considered in management decisions, an assessment of the response of cutthroat trout to the first logging event becomes important. Conclusions from this study could be used to develop prescriptions for stream protection that recognize the short-term and long-term needs for maintaining resident cutthroat populations in small basins of the Coast Range.

All 16 basins sampled are westside drainages of the mid-coastal region of Oregon, with locations ranging from tributaries of the Siletz drainage to the north to Big Creek Basin (Lincoln County) to the south. Field work began in 1991 and was completed in 1993. Size of the watersheds ranged from 0.5 to 3.5 km^2. Seven of the basins were logged 20-30 years ago, five were logged 40-60 years ago, and four have not been logged. The unlogged basins had post-fire stands that were 125-150 years old.

The density of cutthroat trout 1 year old or older, the canopy of trees over the stream, and the quantity of large woody debris in the stream channel varied with the history of forest harvest activity in the basins. Unlogged basins had low densities of cutthroat trout and had the lowest variability in densities within a stand age class (Figure 3). These basins had streams with a small percentage of canopy cover provided by hardwoods (Figure 4) and low amounts of large woody debris (Figure 5). Basins logged 20-30 years ago had the widest range of densities of cutthroat trout, including the lowest and highest densities among all basins sampled. These younger second-growth basins had high percentages of canopy cover provided by hardwoods and highly variable amounts of large woody debris. Basins logged 40-60 years ago had low to moderate densities of cutthroat trout and had an intermediate level of variability of densities among streams. These older second-growth basins

had a moderate to high percentage of canopy cover provided by hardwoods and low amounts of large woody debris. Across all stand age classes (Table 1), density of cutthroat trout 1 year old or older was generally higher (>1.4 g/m^2) in streams that had canopies with low coverage by conifers (<35 percent) and channels with high amounts of large woody debris (>15 pieces/100 m).

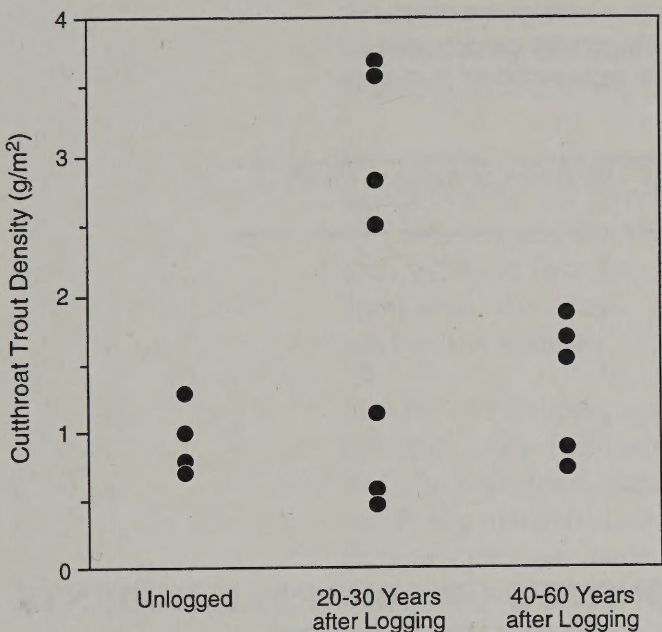

Figure 3. *Summer low-flow densities of cutthroat trout 1 year old or older in 16 streams draining the mid-Coast Range, 1991-93.*

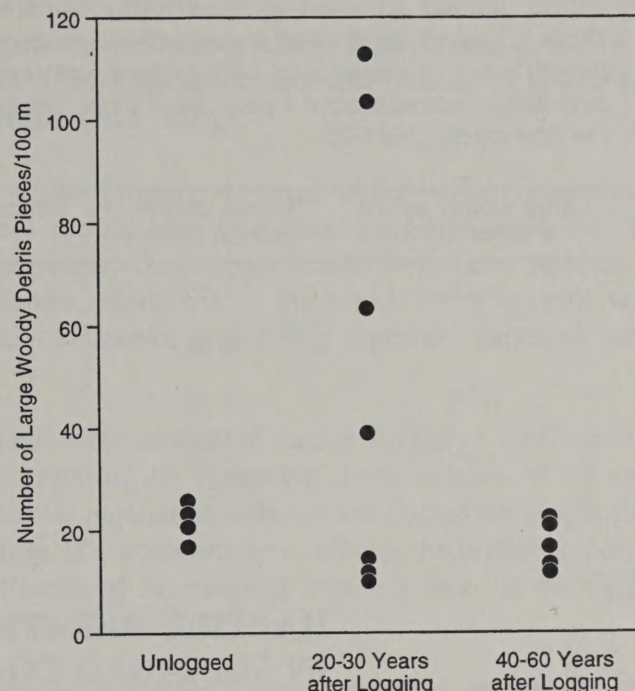

Figure 5. *Frequency of large woody debris. Each piece counted was ≥ 1 m in length and ≥ 30 cm in diameter.*

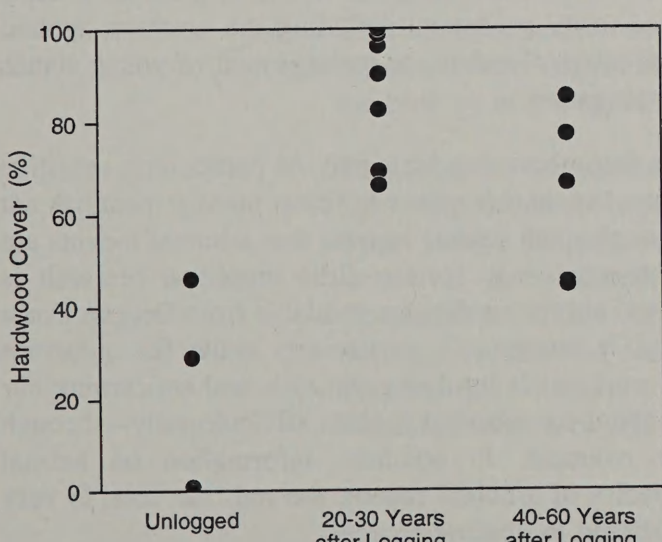

Figure 4. *Percent hardwood in stream canopies.*

These preliminary results suggest that simply providing a stream with riparian buffers may not be adequate for maintaining populations of cutthroat trout in extensively harvested second-growth basins. Many of the second-growth basins within the mid-Coast Range that were harvested 20-60 years ago without provisions for riparian buffers now have riparian zones dominated by hardwoods, especially red alder. Mechanisms that may explain the differences in density of cutthroat trout across stand age classes include the differences in light and nutrient inputs afforded by deciduous versus conifer trees in the stream canopy and the degree of scour and cover afforded by large woody debris. Thus a future management plan that calls for maintaining high densities of young conifers in the riparian area but provides for harvesting of the mature conifers could limit the

productivity of cutthroat trout because of the resulting high levels of shade and low nutrient input. On the other hand, a riparian management plan that does not provide potential for some regeneration of conifers in streamside areas may limit the accumulation of large woody debris, an important element of habitat for cutthroat trout.

Table 1. *Classification of 16 streams based on frequency of large woody debris (length ≥ 1 m, diameter ≥ 30 cm), percent conifer in the stream canopy, and biomass of cutthroat trout 1 year old or older. Streams were sampled at summer low flow during 1991-93.*

Large woody debris pieces/100 m	Percent conifer in riparian canopy	Streams with cutthroat biomass (g/m^2) at ≤ 1.4	> 1.4
≤ 15	≤ 35	2	2
	> 35	1	0
> 15	≤ 35	1	5
	> 35	5	0

HABITAT RELATIONSHIPS OF ARBOREAL RODENTS IN MANAGED COAST RANGE FORESTS

(John P. Hayes, Eric Horvath, and Patrick Hounihan—Adaptive COPE)

Arboreal rodents are important elements of regional biodiversity. They play a critical role in energy flow in Oregon Coast Range forests and are important in dispersal of the spores of mycorrhizal fungi. In addition, arboreal rodents are primary prey species of many predators, including the northern spotted owl. Hence, the response of arboreal rodents to management of young stands is an important area of investigation.

Previous research indicates that arboreal rodents may be particularly sensitive to changes in forest structure, but their response to forest management has not been fully elucidated. Although some studies suggest that arboreal rodents are closely associated with late-seral-stage forests, little empirical research is available on this question, and almost no data are available from Oregon Coast Range forests. The lack of information is particularly acute for questions concerning use of young forest stands by flying squirrels and concerning our ability to create suitable habitat for arboreal rodents silviculturally—through commercial thinning, for example. In addition, information on habitat relationships of another species of arboreal rodent, the red tree vole, is very poor, and much of it is scattered in obscure sources.

A better understanding of the habitat relationships of arboreal rodents will help forest resource managers make more-informed decisions. In this study we

examined the biology of arboreal rodents in the Oregon Coast Range in order to improve our understanding of how various silvicultural and management activities influence arboreal rodent populations in managed forests.

The study has three primary objectives: 1) to determine the relationship between forest structure and habitat utilization by arboreal rodents, 2) to synthesize existing information concerning patterns of habitat utilization, natural history, and biology of the red tree vole, and 3) to determine the value and feasibility of additional field research on arboreal rodents in young and managed forests in the Oregon Coast Range.

For the field component of the project, we are looking at fire-regenerated stands of over 120 years old and Douglas-fir plantations 10-15 years old, 20-25 years old, and 30-35 years old. Three study stands have been selected in each of these four age classes. Mammals in the stands were trapped with Tomahawk live traps. All chipmunks and flying squirrels captured were marked and released.

Two 6-week trapping sessions were conducted during the fall of 1992 and the spring of 1993. Field assessment of the vegetative characteristics of the sites was also completed. Substantial population data were collected for chipmunks and flying squirrels. Densities of chipmunks were among the highest reported from any previous study. Results of the trapping were presented in the *COPE Report* 6(2):4-6 and in the 1993 *Annual Report.*

Analyses of vegetation data for the stands were conducted during the past year. Chipmunk populations were closely associated with percent cover of salal in the understory. The data suggest that management activities that open up the overstory, such as commercial thinning, may enhance the habitat for this species in the Coast Range.

The literature review on red tree voles was completed. Sixty-eight pertinent references were identified and reviewed. A manuscript outlining all aspects of the biology of the species has been prepared and submitted for publication.

This research demonstrated that flying squirrels in some young forest stands can attain densities similar to those found in mature stands in the Oregon Coast Range. In part as a result of our findings from this study, we have joined in a collaborative effort with Robert Anthony of the Oregon Cooperative Wildlife Research Unit to examine the influence of commercial thinning on arboreal rodent populations. Please see the next report in this volume, titled Influence of Silvicultural Operations on Stand Structure and Wildlife Abundance and Diversity in Managed Coast Range Forests.

INFLUENCE OF SILVICULTURAL OPERATIONS ON STAND STRUCTURE AND WILDLIFE ABUNDANCE AND DIVERSITY IN MANAGED COAST RANGE FORESTS

(John P. Hayes, William H. Emmingham, Nobuya Suzuki, Michael Adam, and Jennifer Weeks—Adaptive COPE; William C. McComb and Stephen D. Hobbs—OSU Department of Forest Science; Clint Smith—Oregon Department of Forestry)

Considerable acreage in the Oregon Coast Range, on both public and private lands, is in an early-seral stage of development as a result of a history of fire and logging. Recently, there has been increased interest in enhancing wildlife values while maintaining acceptable levels of wood-fiber production.

Commercial thinning has been proposed as a means of meeting both these resource needs in Coast Range forests. Silvicultural prescriptions are well established for commercial thinning focused on maximizing wood-fiber production; these are based on theoretical and applied studies and substantial practical experience. However, considerably less information exists about how to use silvicultural prescriptions to incorporate wildlife goals into these young stands. Although some preliminary work has addressed this topic, fundamental questions about the response of wildlife populations to thinning activities and snag creation remain unanswered. As a result, the implications of various management strategies with respect to the welfare of wildlife are still unclear.

This study examines the influence of snag density and commercial-thinning intensity on wildlife populations in managed plantations in the Oregon Coast Range. The Adaptive COPE study is being integrated with two other studies on the same study area: an Oregon Cooperative Wildlife Research Unit study of the response of flying-squirrel and chipmunk populations to commercial thinning (principal investigator: Robert G. Anthony), and a Pacific Northwest Research Station study of the response of *Phellinus* root rot to commercial thinning (principal investigator: Walter Thies).

The Adaptive COPE study has three primary objectives: 1) to determine the influence of different commercial-thinning intensities on wildlife habitat and wildlife abundance and diversity; 2) to determine the influence of snag creation in young stands on use by birds; and 3) to determine the influence of commercial-thinning intensity on the development of the stand and the establishment of seedlings. On completion, the project will identify many of the costs and benefits of using thinning operations to enhance wildlife habitat and animal populations.

To meet the first objective, one stand will be left unthinned and two will be commercially thinned, one to moderate spacing and one to wide spacing. The study is being conducted in four replications with treatments randomly assigned to stands within a replication. Three of the replications are located within the Tillamook State Forest and one is on land owned by the Stimson

Lumber Company (Figure 6). Within each replication, we attempted to find treatment areas that are relatively homogenous with respect to hardwood densities and logging systems used. Because treatment areas must be large enough to result in identifiable, unambiguous responses of wildlife populations, each treatment area is at least 65 acres in size. Logging of the treatment areas will be completed between July 1994 and April 1995.

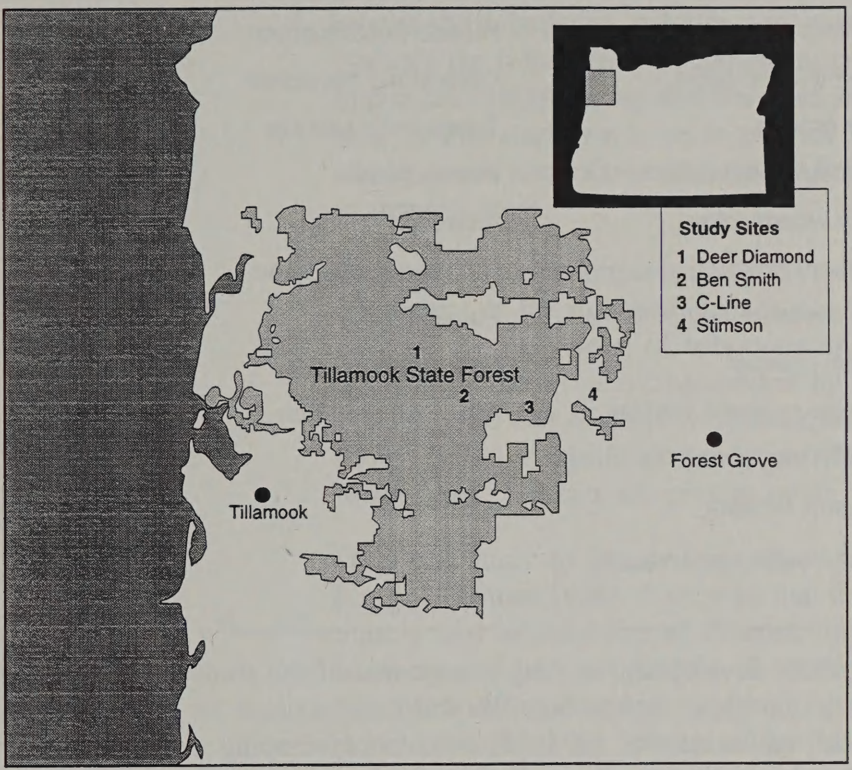

Figure 6. Location of study sites.

This year was the first in which data were collected, and it was a highly productive one. Pretreatment surveys of the stands, completed during the spring of 1994, included data for small-mammal, amphibian, and bird populations, and for vegetation.

Small-mammal and amphibian populations were surveyed by means of pitfall trapping. A grid of 25 stations, with 80 m between each station, was established in each stand. Two pitfall traps were placed at each station, and the traps were checked for 6 weeks from early May through mid-June. Data summary and analysis for the pretreatment session continues.

Bird populations were surveyed during the breeding season, between mid-May and mid-June. Five survey points were established in each stand, and all birds seen or heard during an 8-minute period within 80 m of the survey points were recorded. Each survey point was visited seven times during the sample period. A total of 42 species were seen or heard in the stands during the survey (Table 2). Bird-population data will be analyzed before the beginning of the next field season.

Detailed information on vegetation was collected in June and July of 1994 at each of the stations used for the small-mammal and amphibian study. Various data were collected from a series of plots ranging from 1 m^2 to over 700 m^2, including information on physical characteristics of the site, ground cover, composition and cover of herbaceous species and shrubs, canopy cover, tree density and size, amount of snags and woody debris, and number of seedlings. A preliminary analysis will be completed before the next field season.

Table 2. Birds identified during the pretreatment sample period.

Species frequently detected	Species occasionally detected	Species rarely detected
Pacific-slope flycatcher	Gray jay	Turkey vulture
Winter wren	Steller's jay	Red-tailed hawk
Golden-crowned kinglet	Common raven	Sharp-shinned hawk
Chestnut-backed chickadee	American crow	Northern pygmy owl
Swainson's thrush	Hutton's vireo	Rufous hummingbird
Varied thrush	Band-tailed pigeon	Olive-sided flycatcher
Warbling vireo	Blue grouse	Townsend's solitaire
Hermit warbler	Pileated woodpecker	Hermit thrush
Black-throated gray warbler	Hairy woodpecker	American robin
Wilson's warbler	Northern flicker	Rufous-sided towhee
Dark-eyed junco	Red-breasted nuthatch	Purple finch
Evening grosbeak	Brown creeper	Pine siskin
Red crossbill	Orange-crowned warbler	American goldfinch
	MacGillivray's warbler	
	Western tanager	
	Black-headed grosbeak	

We are currently developing the snag component of the study and exploring the feasibility of various approaches. We will finalize plans for creating snags during the fall and winter of 1994. We are also developing a study plan for installation and monitoring of a number of big-game exclosures, with the objective of determining the effect of big-game browsing on vegetation and reforestation in the Tillamook State Forest.

HABITAT RELATIONSHIPS AND RIPARIAN-ZONE ASSOCIATIONS OF BATS IN MANAGED COAST RANGE FORESTS

(John P. Hayes and Patrick T. Hounihan—Adaptive COPE; Stephen P. Cross—Department of Biology, Southern Oregon State College)

Studies of several species of vertebrates are beginning to clarify the relationships between wildlife and habitat structure, making it possible to evaluate the influence of management programs on wildlife populations. One important wildlife group that has been neglected in these studies, however, is bats. In this study we hope to provide the scientific basis to evaluate forest management alternatives that may influence bat populations in and adjacent to riparian areas.

Bats are extremely important to the region's biodiversity and ecology. Nearly 20 percent of the mammal species occurring in the Oregon Coast Range are bats. Of the 11 species of bats occurring in the Coast Range and Siskiyous, three are listed as sensitive species by the Oregon Department of Fish and Wildlife, and one of these is a candidate for federal threatened or endangered status. Bats are significant predators of nocturnal insects, some of which are forest pests, and bats are prey to other mammals and birds.

Only one study to date has examined bat communities in the Oregon Coast Range (Thomas 1988). It showed that the abundance and diversity of bats are closely tied to stand age of forested upland areas. Upland habitat is used by many species of bats primarily as roosting habitat. Riparian zones are used by bats for both roosting and foraging. Although there is some evidence that bat populations may be influenced by habitat structure in riparian zones, no definitive studies have examined this relationship.

The goals of this study are: 1) to identify the bat species in the Oregon Coast Range that utilize riparian zones, 2) to determine the importance of riparian zones to these species, and 3) to determine the influence of landscape structure, forest structure, and stream and riparian characteristics on patterns of habitat utilization by bats.

Before we could determine the most appropriate experimental design, we first needed to gather some basic information. Our preliminary studies have focused on two basic questions: 1) what are the echolocation signatures of different species of bats in the Oregon Coast Range, and 2) how much temporal variation in activity occurs among nights along riparian zones in the Coast Range?

Initial research has relied primarily on monitoring echolocation calls to determine patterns of use of riparian areas. The various species of bats emit different frequencies of sound while echolocating during their foraging and orientation activity. In an attempt to identify echolocation signatures of different species of bats, we caught bats with mist nets and recorded their calls when the bats were released. From these recordings we are building a

catalogue of bat calls, with each call depicted as a time-frequency curve (Figure 7). We will use this catalogue to identify species on the basis of the shape, duration, maximum frequency, and minimum frequency of the curves.

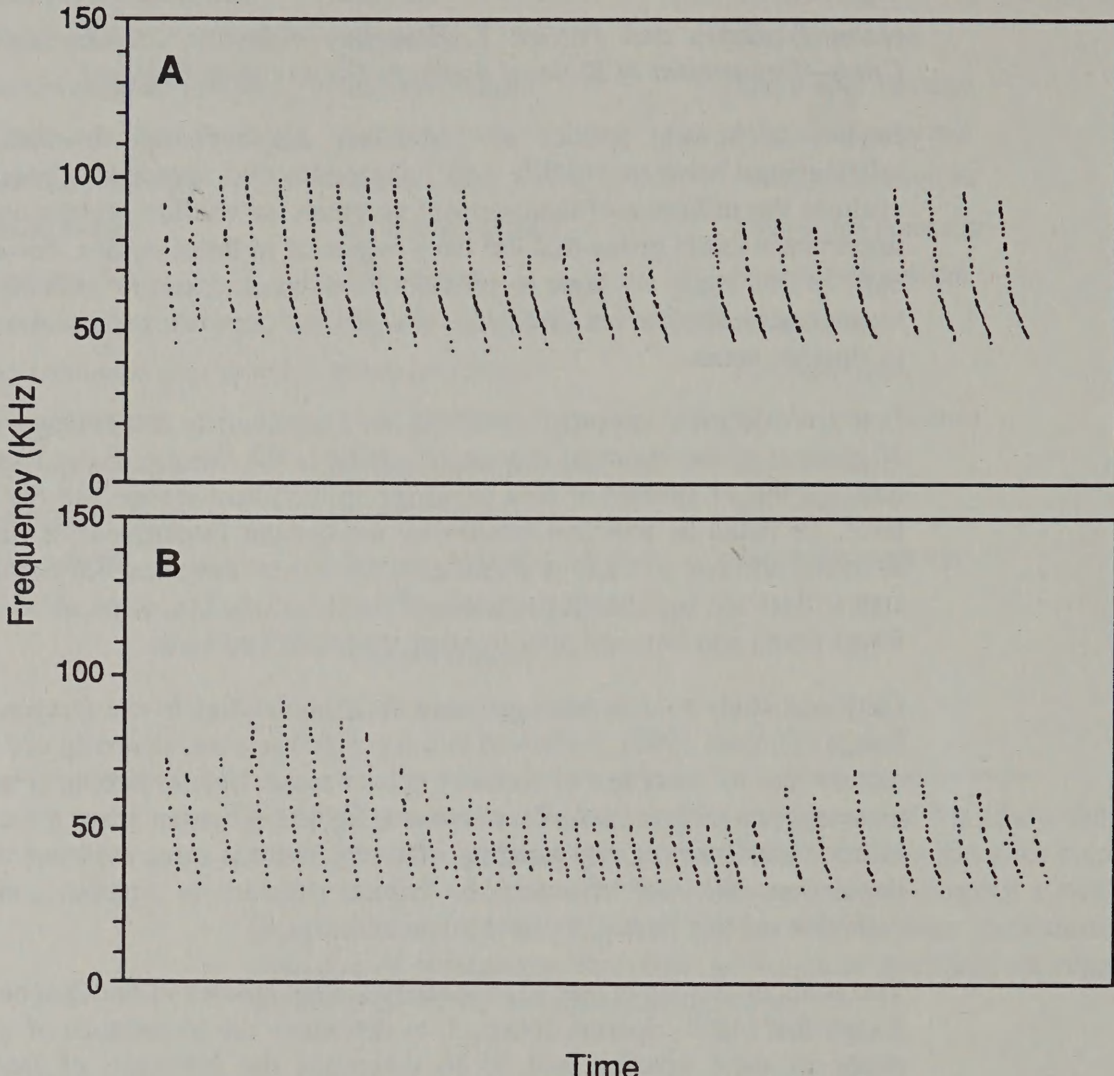

***Figure 7.** Echolocation signatures of the Yuma myotis* (Myotis yumanensis) *(A) and the long-eared myotis* (Myotis evotis) *(B).*

For example, our preliminary work suggests that the echolocation pulse of the Yuma myotis *(Myotis yumanensis)* in the central Oregon Coast Range is relatively steep, has a sharp inflection point, lasts 3-7 milliseconds, and has a maximum frequency around 100 KHz and a minimum frequency between 40 and 47 KHz (Figure 7A). In contrast, the echolocation pulse of the long-eared myotis *(Myotis evotis)* has no sharp inflection point, lasts only 1-3 milliseconds, and is lower in frequency, with minimum frequencies between 30 and 35 KHz (Figure 7B). Although we may not be able to determine differences in echolocation patterns between all species of bats, we are confident that we will be able to identify all calls to the genus level and many to the species level.

To determine temporal patterns of variation, we monitored bat activity at two streams, Bark Creek and Buttermilk Creek, on 30 nights from July through September of 1993. We found that Bark Creek experienced about five times as much activity as Buttermilk Creek. There was also substantial temporal variation in activity during this time, with nightly activity varying more than tenfold at each stream (Figure 8). However, the temporal variation was not random; a "good night" for bats at one location was generally also a "good

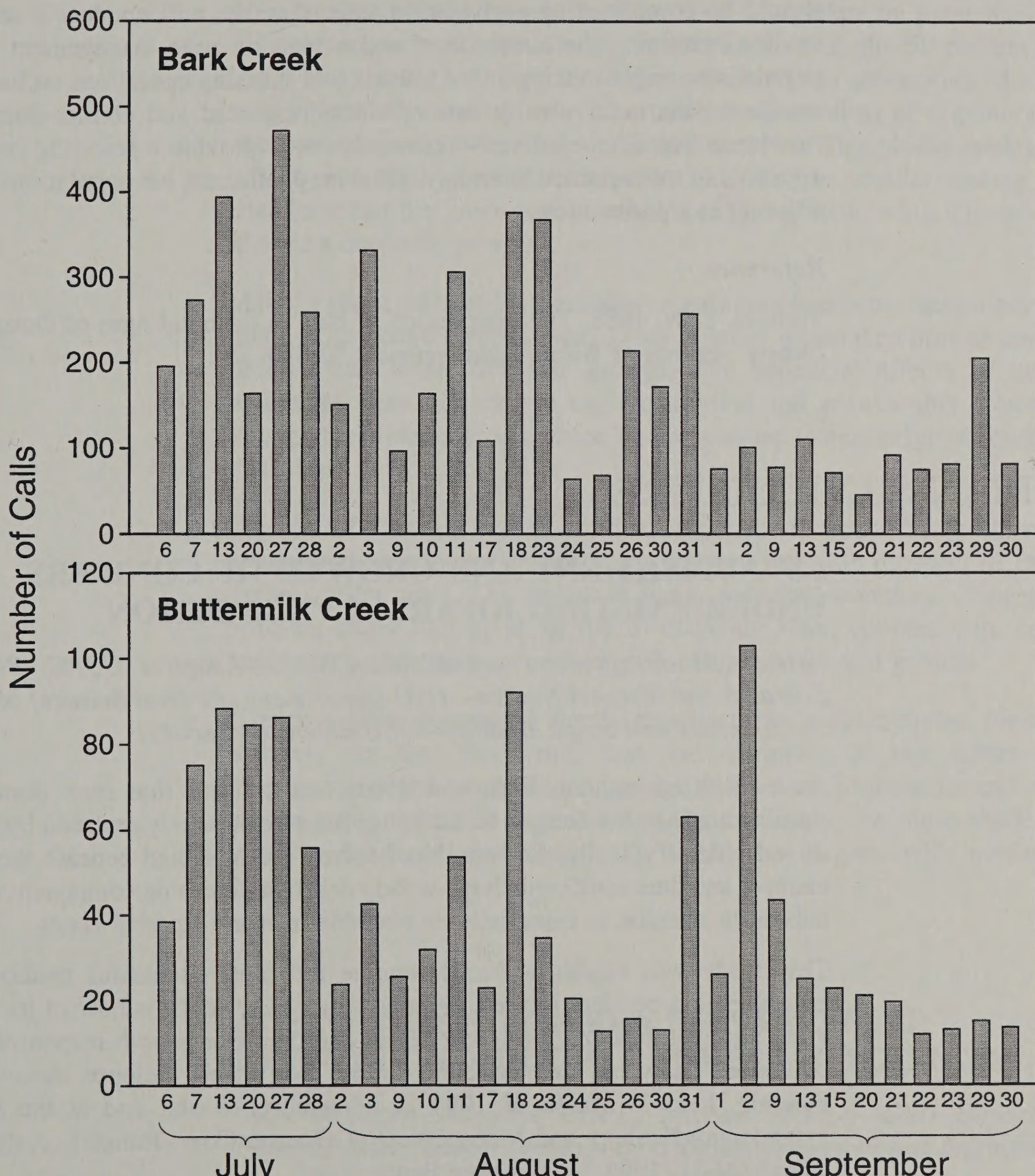

Figure 8. Number of bat calls recorded at Bark and Buttermilk Creeks on each of 30 nights during July through September of 1993.

night" at the other. This temporal pattern of variation appears to be closely associated with minimum nightly temperatures. As a result of these findings, we will structure our activity monitoring program so that comparisons are paired by night, thereby minimizing extraneous variation due to weather conditions. We will try also to identify other factors that affect levels of bat activity so that these influences can be accounted for in the experimental design.

Our analyses of echolocation signatures and patterns of temporal variation should be completed by early 1995. After that, we will conduct a series of studies examining the influence of active riparian-zone management on bat populations, begin looking at the influence of thinning operations on bats, and compare patterns of use by bats of alder-dominated and conifer-dominated riparian zones. The results of these studies will provide a scientific basis for appraisal of management alternatives that may influence bat populations in and adjacent to riparian areas.

Reference

Thomas, D.W. 1988. The distribution of bats in different ages of Douglas-fir forests. *Journal of Wildlife Management* 52:619-624.

RIPARIAN SILVICULTURE

ESTABLISHMENT AND GROWTH OF CONIFERS UNDER EXISTING RIPARIAN VEGETATION

(William H. Emmingham and Kathleen Maas—Adaptive COPE; Barbara Schrader and Michael Newton—OSU Department of Forest Science; Michael J. Cloughesy and Ralph Duddles—OSU Extension Service)

As a result of logging, fires, and floods, the conifers that once dominated riparian zones in the Oregon Coast Range have been largely replaced by stands of red alder. Typically, few conifers become reestablished beneath the alder canopy, and thus coniferous large woody debris, a desirable component of fish habitat in streams, is essentially unavailable in many riparian zones.

This study was established to determine the most successful methods for reestablishing conifers in these riparian zones. The study is now in its fourth year. Survival data and third-year height and diameter growth responses were collected, analyzed, and reported at the Northwest Science Association meeting, held in March of 1994 at Ellensburg, Wash., and at the COPE symposium, Ecology and Management of Oregon Coast Range Forests, held March 29-31, 1994, at Gleneden Beach, Ore.

Six sites were selected along the west side of the Coast Range. Four conifer species, Douglas-fir, western redcedar, western hemlock, and grand fir, were underplanted 2 m apart in each subplot. Half the trees in each planting were

encased in Vexar™ tubing to protect them from browsing by animals. The overstory was treated by killing either 50 or 100 percent of the alder trees by girdling or injecting with herbicide. Understory vegetation was also controlled in half of each overstory treatment area. Seedlings were measured for height, diameter at ground level, and diameter at 15 cm above the ground after planting and after the first, second, and third growing seasons.

By the end of the third growing season, estimates of overhead cover were 95, 55, and 8 percent for the undisturbed control areas, partial treatment areas, and total treatment areas, respectively. Survival of conifers on good sites was 68-73 percent, on poor sites 52-60 percent. Survival in the 50-percent removal areas was similar to that in the 100-percent removal areas. Redcedar survival was better than survival in the other species. Controlling of vegetation in both the overstory and understory increased survival. The plastic tubing had no effect on either survival or growth. Growth was similar among species. Hemlock had the greatest diameter and height growth, while Douglas-fir had the least diameter growth.

After 3 years, trees in both overstory treatments had better height growth than trees in untreated control areas. Trees in areas where the entire overstory was girdled had better diameter growth. The beneficial effects of understory treatment were still seen in conifer survival and growth after 3 years, even though the understory vegetation had rebounded to near original conditions by that time.

Results of this and other survival and growth trials has confirmed that underplanting without treating the overstory has little prospect of producing large conifer trees. On the other hand, reducing overstory competition by girdling either half or all of the overtopping alder, coupled with control of understory vegetation, produced promising survival and growth.

Thinning alder-dominated stands appears to be a good option for restoring conifers in the short run, but the duration of the effect of this treatment—which would depend on age and density of the alder and condition of the site—should be assessed first. In this study, the more shade-tolerant conifers did better, but Douglas-fir survived and grew with modest initial success.

ACTIVE RIPARIAN-AREA MANAGEMENT: EFFECTS ON MULTIPLE FOREST RESOURCES

(Arne Skaugset—Adaptive COPE; Michael Newton—OSU Department of Forest Science; Loren Kellogg—OSU Department of Forest Engineering)

In general, large woody debris in streams improves habitat conditions for salmon and trout. COPE research has found that Coast Range riparian zones, whether regenerated naturally or artificially, can be dominated by hardwood overstories with shrub understories. In hardwood-dominated riparian areas,

conifer regeneration is usually nonexistent or suppressed, raising the concern that these areas, if left alone, will not become source areas for future coniferous large woody debris. A further concern is that, because of the tendency of riparian areas to regenerate to hardwoods, a fixed-width buffer strip with management exclusion could exacerbate the problem.

Research by COPE and other scientists suggests that debris from conifers is best for fish habitat. COPE studies have found that streams flowing through unharvested stands in the Oregon Coast Range had a higher piece count of large woody debris than streams flowing through second-growth stands or mixed harvested and unharvested stands, and they had more than twice the volume of large woody debris. Streams flowing through conifer and mixed conifer/hardwood riparian areas had similar numbers of pieces of large woody debris as streams flowing through hardwood-dominated riparian areas, but they had about twice as much debris volume. These studies suggest that the abundance of conifers growing along a stream is a good indicator of the future abundance of woody debris in the stream.

This research has prompted efforts to develop a management strategy that will get conifers growing in riparian zones. Called active riparian-area management (ARAM), this strategy is in contrast to the riparian-area management paradigm of the past several decades, which views riparian areas as management exclusion zones. Active riparian-area management encompasses two areas of interest: 1) riparian silviculture—methods of establishing and growing conifers in hardwood- and shrub-dominated riparian areas; and 2) stream enhancement—adding large woody debris to streams to increase the amount and quality of fish habitat.

The COPE Program has several riparian-silviculture projects in progress, aimed at determining the effects of overstory and understory manipulation on the establishment and growth of conifers. Only preliminary results from these studies are available, but they indicate that, in general, some level of removal of the overstory or understory is required for optimum survival and growth of conifer seedlings. Several stream-enhancement projects are also installed. These have the goal of determining the effects of piece size, orientation, and complexity of woody debris on fish habitat.

In 1993, a comprehensive project was initiated to bring both riparian-silviculture and stream-enhancement research together on an operational scale and to add a harvest-engineering component. The study area for the project consists of three harvest units located on industrial forest land in the central Oregon Coast Range. All three units have debris-poor streams flowing through them, with riparian areas dominated by alder and shrubs and lacking in conifer regeneration. The harvest unit extends along approximately 2,000 ft of each study stream. At the upstream and downstream ends of the harvest unit, 300-ft-long openings were installed. Between these openings, 100-ft-wide buffer strips were left along each side of the stream. An additional 600-ft opening was cut on the stream or on an adjacent tributary. See *COPE Report* 7(1):2-5

or Adaptive COPE's 1993 *Annual Report* for a more detailed discussion of the study design.

For the riparian-silviculture research, one or two stocktypes of three conifer species were planted within each riparian opening. The effect of opening size, species, stocktype, weeding, distance from the stream, and distance from overstory trees on seedling survival and growth will be determined. For the stream-enhancement research, logging equipment was used to place large woody debris pieces in the 300-ft openings in two configurations. The stability of the large woody debris and its effect on fish habitat will be determined. The effect of the openings on stream temperature and aquatic insects also will be investigated, as will the effect of logging the 300-ft openings on streambed and bank disturbance. Finally, the logging-engineering research will determine the costs of planning and harvesting the riparian openings and constructing the large woody debris jams in the streams.

All three replications are installed. Two of the replications, Bark Creek and Buttermilk Creek, were completed last summer (1993) and the final replication, Hudson Creek, was completed this summer (1994). Six debris jams were constructed in Bark Creek; two were keyed by large Douglas-fir logs and four were keyed by alders with intact rootwads. The Douglas-fir logs were yarded from within the harvest unit and placed in the stream with the skyline yarding equipment. The alders were pulled into the stream with rootwads intact, also using the skyline yarding equipment. Five debris accumulations were constructed in Buttermilk Creek; two were keyed by large Douglas-fir and the remaining three were keyed by alders, two with rootwads attached. Because of fisheries concerns, the stream-enhancement activities were carried out during the summer after the yarder was gone, and so a hydraulic excavator was used. The large woody debris loading for Bark and Buttermilk Creeks after logging and debris placement is shown in Figure 9.

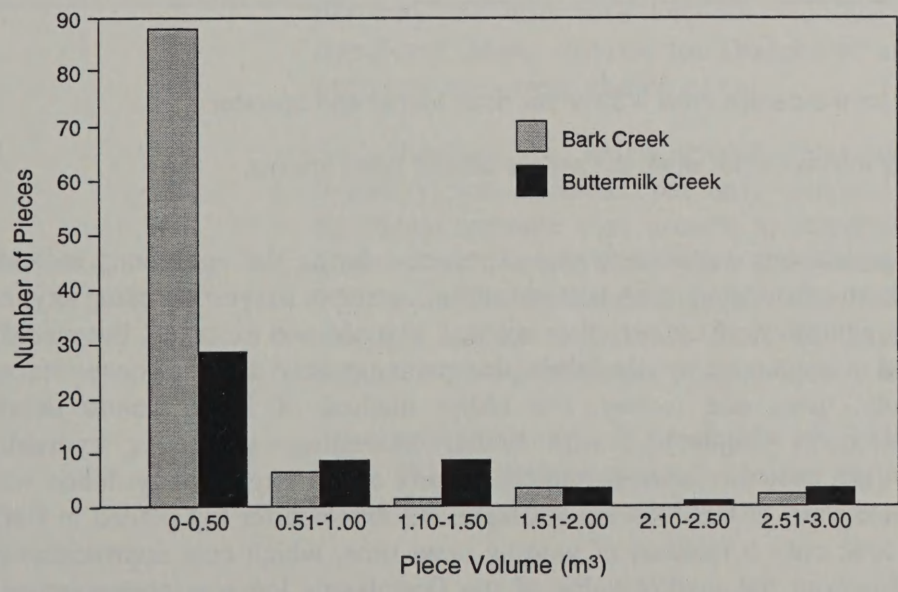

Figure 9. *Number of pieces and size distribution of large woody debris in Bark Creek and Buttermilk Creek following timber harvesting.*

All the pre- and post-harvest data have been collected for Hudson Creek; however, it is not yet summarized. Preliminary logging-engineering results for the debris placement in Bark and Buttermilk Creeks are available, as are the amounts of large woody debris installed and some stream-temperature data. Cost estimates for constructing the large woody debris jams are shown in Table 3. These estimates include market value for the logs placed in the stream and an estimate of costs incurred while placing the debris pieces during harvesting.

Table 3. *Timber value and operations costs for stream enhancement.*

Timber value	Bark Creek installation during skyline yarding		Buttermilk Creek installation with faller and hydraulic loader	
	Number of logs or trees	Value ($)	Number of logs or trees	Value ($)
Douglas-fir logs [a]	2	495	6	580
Alder trees [b]	3	161	15	716
Subtotal		656		1,296
Operations Costs				
Skyline yarding equipment and crew [c]		200		
Faller				134
Hydraulic loader and operator				590
Move in/out				400
Subtotal		200 [d]		1,124
Grand total		856		2,420

[a] $500/mbf stumpage value
[b] $310/mbf stumpage value
[c] Yarder owning and operating cost for a 5-person crew = $212 per hour; loader and operator not included.
[d] Six hours of down time incurred by the contractor when the skyline tailhold failed are not included in the costs.

These preliminary results and our experience during the operations indicate that stream enhancement can take place during timber harvesting using skyline yarding equipment if the activities are well planned and executed, but quickly initiated or unplanned woody debris placement can have adverse consequences in safety, time, and money. For either method of large woody debris installation in conjunction with timber harvesting—yarder or hydraulic loader—the choice of species and the quality of the large woody debris will determine most of the cost. For example, the first conifer log placed in Bark Creek took only 5 minutes of yarding crew time, which cost approximately $17. However, the market value of the Douglas-fir log was conservatively estimated at $280.

RELEASE OF SUPPRESSED CONIFERS IN ALDER-DOMINATED RIPARIAN ZONES

(William H. Emmingham and Kathleen Maas—Adaptive COPE; Barbara Schrader—OSU Department of Forest Science; Steve McConnell—Department of Forest Resources, University of Idaho; Doug Bateman, Eric Horvath, and Pat Hounihan—Adaptive COPE)

Woody debris in streams is a key element in healthy fish habitat. Studies indicate that woody debris from conifers is both more abundant and more durable than that from hardwoods. Because riparian zones are sources of large woody debris in streams, suppressed conifers in the riparian zone should not be overlooked as potential future woody debris.

This project was established to determine the best techniques for releasing suppressed conifers in the understory through thinning. The study is being conducted in six riparian areas, three on federal land and three on private industrial land. Approximately 50 understory conifers were identified at each site. Two-thirds of the trees at each site were subjected to one of two treatments, cutting or girdling of surrounding trees, and one-third were left untreated as a control.

The study is in its fourth year. Third-year height and diameter growth responses were collected and reported at the Northwest Science Association meeting, held in March of 1994 at Ellensburg, Wash., and the COPE symposium, Ecology and Management of Oregon Coast Range Forests, held March 29-31, 1994, at Gleneden Beach, Ore. These data were also reported in *COPE Report* 7(2&3):13-15.

Mean 3-year survival ranged from 73 to 95 percent on all six sites but did not vary significantly by site. Survival of western redcedar (95 percent) averaged better than that for Douglas-fir (78 percent) and western hemlock (75 percent), but only the difference between redcedar and hemlock was statistically significant. Mean survival for Douglas-fir and hemlock was greater where overstory trees were girdled or cut.

Both diameter and height growth rates had increased 3 years after the overstory was removed, but only diameter growth showed a statistically significant increase over growth in untreated areas. Mean 3-year diameter growth was 1.7 cm in areas where the overstory was removed, compared with 0.6 cm in the undisturbed stands. The more shade-tolerant hemlock and redcedar tended to increase more in diameter than Douglas-fir in both treatments, but trends were not statistically significant.

In summary, releasing of conifers in small clearings or partially cut riparian-zone alder stands enhanced conifer survival and growth and thereby contributed to stream rehabilitation.

INFLUENCE OF WOODY DEBRIS PIECE SIZE AND ORIENTATION ON FUNCTION IN SMALL STREAMS

(Arne Skaugset—Adaptive COPE; Bob Bilby—Weyerhaeuser Co.; Jim Sedell—USDA Pacific Northwest Research Station)

The role of large woody debris in forest streams has become much better understood over the last two decades. Research has shown that large woody debris improves fish habitat by increasing pool types and sizes, sediment storage, and local scour. However, simply knowing that "wood is good" is insufficient for making site-specific prescriptions that include the number and size of woody debris pieces required to maintain adequate aquatic habitat. The goal of this project is to help provide such information for Coast Range headwater streams by investigating the effects of the size and orientation of large woody debris pieces on debris stability, stream channel morphology, and aquatic habitat.

Woody debris of three different sizes—8, 16, and 24 inches in diameter—were placed in two cobble-bedded, sandstone coastal headwater streams at two different orientations: "spanners" were placed perpendicular to streamflow and resting on the bottom of the channel, and "ramps" were oriented downstream at approximately 45 degrees to streamflow. Both spanners and ramps were free to rise during high flows. Thirty-six debris pieces were installed during the summer of 1989.

Data collection consisted of inventories of both fish habitat and fish population. Fish habitat inventories identified stream reaches as pools, glides, or riffles and measured their width, length, and depth. A census of fish populations was taken by electro-shocking. A topographic map of the stream channel was made so that changes in channel morphology, such as local scour and fill, could be monitored.

Data have been collected and analyzed for the project through the summer of 1993. The latest results are summarized in *COPE Report* 7(4):3-6. The results show clearly that the addition of large woody debris had an effect on local scour and pool development. The results focus on residual pool volume—the volume of water that would remain in pools in a stream if surface flow should cease. Residual pool volumes are determined from the topographic maps of the streams. The two study streams, J-Line Creek and Preacher Creek, had increases of 679 percent and 304 percent, respectively, in residual pool volume between 1989 and 1993. In J-Line Creek, total residual pool volume went from 1.1 m^3 in 1989 to 7.7 m^3 in 1993. In Preacher Creek, residual pool volume went from 2.5 m^3 in 1989 to 7.9 m^3 in 1993.

Because residual pool volume is also caused by naturally occurring woody debris and non-debris structures such as boulders, not all of the increase in residual pool volume can be attributed to the treatments. In Preacher Creek,

the residual pool volume not associated with the treatments is 4.4 m^3, or 57 percent of the total, and in J-Line Creek it is 2.2 m^3, or 29 percent of the total. Thus, 43 percent of residual pool volume in Preacher Creek and 71 percent in J-Line Creek is directly attributable to the large woody debris added as treatments to the streams. Figure 10 shows the distribution of residual pool volume attributable to all factors including treatment debris.

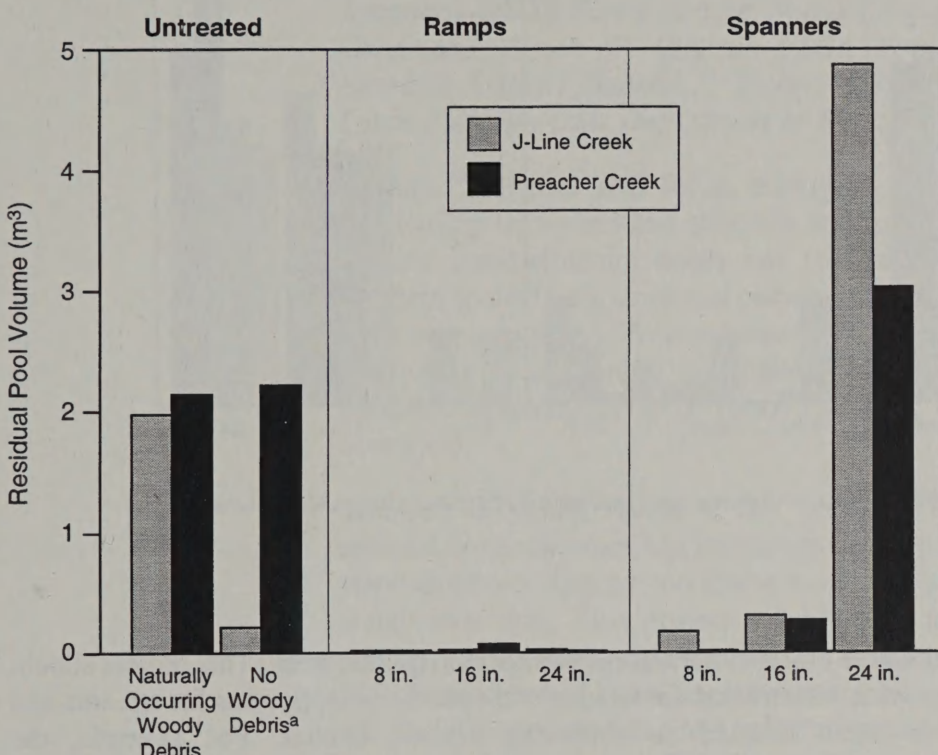

Figure 10. Residual pool volume in treated and untreated pools along J-Line Creek and Preacher Creek.
[a] Residual pools caused by non-debris structures such as boulders.

The most effective treatment for developing residual pool volume was adding large spanners. Of the residual pool volume attributed to treatment debris, 90 and 84 percent in J-Line Creek and Preacher Creek, respectively, were associated with the 24-inch spanners.

The data clearly show a treatment effect on densities of older cutthroat trout (i.e., excluding the young of that year). Pools with large spanners (16 and 24 inches) have cutthroat trout densities similar to those in naturally occurring pools, while the other treatments have cutthroat trout densities similar to those in riffle and glide habitats (Figure 11). Most trout were found in pools associated with the 24-inch spanners.

Densities of juvenile coho, steelhead, and young-of-year trout were highly variable, and no clear trend was obvious. Other factors such as interactions with other populations or mortality associated with migration and ocean conditions appear to have overwhelmed any treatment effect.

Results from this project should be helpful for predicting habitat improvements when debris is added to streams as a part of enhancement projects and for

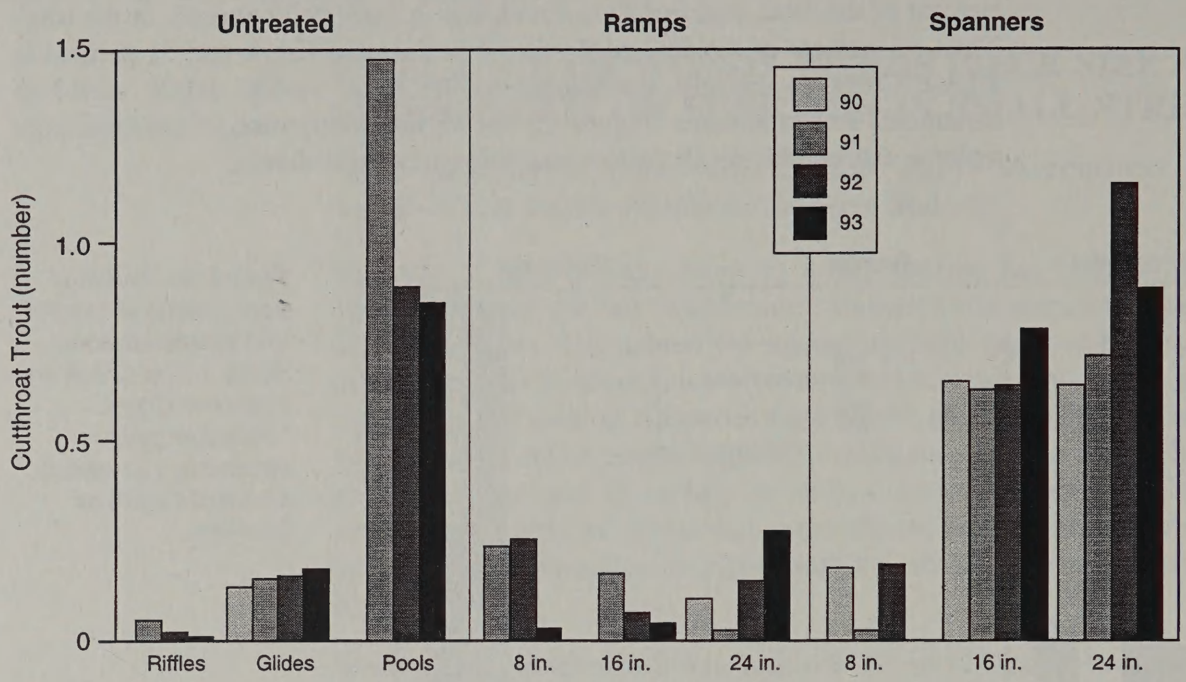

Figure 11. *Density of cutthroat trout in treated and untreated reaches along J-Line Creek and Preacher Creek.*

modeling the effect of natural recruitment of riparian trees. This project should also provide information for writing site-specific prescriptions for streams and riparian areas directed at improving aquatic habitat. For example, the preliminary results from this project clearly show that if the objective is to affect local scour and develop pools for summer habitat in cobble-bedded, sandstone headwater streams in the central Oregon Coast Range, an effective way to accomplish this is to install large logs perpendicular to the stream flow and flush with the stream bottom.

COMMERCIAL THINNING AND UNDERPLANTING TO ENHANCE STRUCTURAL DIVERSITY OF YOUNG DOUGLAS-FIR STANDS

(William H. Emmingham and Kathleen Maas—Adaptive COPE; Stuart Johnston—USDA Forest Service, Siuslaw National Forest; Don Minore, Sam Chan, and Peyton W. Owston—USDA Forest Service, Pacific Northwest Research Station; Gabriel F. Tucker—OSU Department of Forest Science; Loren Kellogg—OSU Department of Forest Engineering)

Wildlife biologists and forest ecologists are beginning to understand the relationship between stand structure and forest ecosystem function. Although specific stand-structure needs are still unknown for species such as the northern spotted owl, structural patterns resembling those of old-growth forests have been suggested. Present knowledge of stand-density dynamics suggests that young stands can be manipulated to provide many of these old-growth habitat characteristics in a relatively short time frame (i.e., decades vs. centuries).

Thinning of young stands to low densities will stimulate rapid growth of residual dominant trees and encourage development of the understory. Current stand-dynamics data are too sparse to reliably project the development of such stands over time. This project will establish and monitor an array of stand-density management regimes designed to create multi-storied stands. Its goal is to form a base of knowledge for determining how quickly forest stands that are partially harvested and underplanted improve as habitat for wildlife species associated with old-growth or late-successional forests.

Our approach is to thin young (approximately 30-year-old) plantations to a variety of densities, including average (100 trees per acre), wide (60 trees per acre), and very wide (30 trees per acre). Control areas with 200-400 trees per acre will be left unthinned. In addition, hemlock and Douglas-fir will be planted in the understory of all areas to test their contribution to the development of vertical structure. Alder will be underplanted in *Phellinus weirii* root-rot pockets. In each of the density treatments, five conifer species, Douglas-fir, western hemlock, western redcedar, grand fir, and Sitka spruce, and two hardwoods, red alder and bigleaf maple, will be tested for survival and growth in underplanting trials. Development of understory vegetation, changes in microclimate, and development of overstory crowns all will be monitored in cooperation with the PNW Research Station and the Siuslaw National Forest.

These various overstory densities and understory management regimes will provide a wide array of vertical structures at various time intervals. We believe that some of them will result in old-growth-like habitat much sooner than would occur in unmanaged stands. All the manipulations are being done at commercial thinning age so that the operations will be economically viable.

The study is in its second year. Three replications have been installed; stands have been thinned and trees planted, and microclimate is being monitored. Numerous field trips have been conducted, initially on the first replication on the Mapleton Ranger District, but more recently on the Waldport and Hebo Ranger District replications. Data on logging costs were collected while the latter two replications were being installed during the winter of 1993-94. Data on the first-year survival of seedlings planted at Mapleton in the spring of 1993 have been collected and summarized for *COPE Report* 7(4):6-7.

This study should provide key information that will enable forest managers to move toward an ecosystem approach to management, one focused on sustaining processes that keep ecological systems diverse, healthy, and productive. The study will also provide basic information for landowners who wish to manage stands with increased structural diversity over a long rotation.

PRUNING AND FERTILIZING PRECOMMERCIALLY THINNED DOUGLAS-FIR STANDS IN THE OREGON COAST RANGE

(William H. Emmingham and Kathleen Maas—Adaptive COPE; Ralph Duddles—Forestry Extension Agent, Coquille; Ronald Durham—Menasha Corporation, Coos Bay)

With the increasing scarcity of timber, forest managers need to know how much they can increase forest volume and value yield from intensive forestry practices, which include thinning, pruning, and fertilization. Many studies have looked at fertilization of Douglas-fir stands in the commercial-thinning size and age range. A few studies have looked at pruning Douglas-fir. It is well known that fertilization can profitably be combined with proper thinning regimes, but no studies in the Oregon Coast Range have investigated the combined effects of pruning and fertilization on young, precommercially thinned Douglas-fir stands.

The practice of fertilizing Douglas-fir is well founded. Trials established by the Pacific Northwest Stand Management Cooperative research program at the University of Washington have demonstrated its efficacy, and forest fertilization is practiced operationally on thousands of acres each year. The most cost-effective programs fertilize thinned stands that can be harvested or thinned again in 6-10 years. This approach minimizes the length of time between investment and return.

Recent studies by the PNW Research Station have demonstrated that trees pruned 20-30 years ago will produce enough value when they are properly milled to more than pay for the investment in pruning. Moreover, pruned stands could eventually provide high-quality, clear wood—a commodity that has become scarce as old-growth and mature forests have been logged off or

put into reserves. Internationally, forestry enterprises have already begun investing heavily in pruning; New Zealand is a good example.

Our objectives in this study are to determine the efficacy of fertilizing young, precommercially thinned Douglas-fir stands and young, pruned, precommercially thinned Douglas-fir stands; and to quantify the growth, form, and branch size of trees in fertilized and unfertilized plots in stands that have: 1) had no treatment, 2) been precommercially thinned, and 3) been precommercially thinned and pruned. Our approach is to investigate the earliest possible opportunity to capitalize on the well-known growth response produced by fertilizing thinned stands; i.e., at the time of the first commercial thinning. The study will be conducted on Menasha Corporation lands near Coos Bay. The area is located within a 15-minute drive from Coos Bay and is adjacent to the Menasha Demonstration Forest.

This year, we laid out study plots, randomly assigning six treatments in three replications. All plots are within a few miles of one another. We installed precommercial thinning, pruning, and fertilization treatments, collected and summarized data on initial post-treatment conditions, and made a site-coordination visit. Still to be done this year is the writing of an establishment report.

This study complements other COPE studies that address intermediate stand treatments, an area of concern that emerged in 1992.

EDUCATION

To ensure that research information developed by COPE is quickly available to a broad audience, Adaptive COPE team members publish scientific papers, reports, and a quarterly newsletter; organize workshops; make formal presentations; lead field tours, and consult with cooperators. Forestry Extension agents help in bringing COPE research findings and activities to the attention of the general public via their county Extension newsletters and workshops.

NEWSLETTER

The *COPE Report* was mailed to over 2,100 subscribers this year. This report rapidly disseminates research findings, announces forthcoming educational opportunities, and highlights recent publications and topics of interest. The goal of the newsletter is to consistently and effectively inform cooperators and other interested persons about COPE activities and about general developments in resource management. This year's four issues are reprinted in the Appendix to this report, along with the October 1993 issue (6.3).

PUBLICATIONS AND REPORTS

Hayes, J.P., and P. Hounihan. 1993. Spatial and temporal variation in bat activity in echolocation monitoring studies (abstract). *Bat Research News* 34:111.

Hayes, J.P., E.G. Horvath, and P. Hounihan. 1994. Securing live traps to small diameter trees for studies of arboreal mammals. *Northwestern Naturalist* 75:31-33.

Hayes, J.P., and P. Hounihan. 1994. Field use of the Anabat II bat detector system to monitor bat activity. *Bat Research News* 35:1-3.

Hayes, J.P. *Neotoma magister*. *In* D.E. Wilson, ed., *Complete Book of North American Mammals* (in press).

Hayes, J.P., E.G. Horvath, and P. Hounihan. Townsend's chipmunk populations in Douglas-fir plantations and mature forests in the Oregon Coast Range. *Canadian Journal of Zoology* (in press).

Kellogg, L.D., S.J. Pilkerton, and A.E. Skaugset. 1993. Harvesting for active riparian zone management and the effects on multiple forest resources. *In* Environmentally Sensitive Forest Engineering: Proceedings of the 16th Annual Meeting of the Council on Forest Engineering. August 8-11. Savannah, Georgia.

ALTERNATIVE SILVICULTURE TREATMENTS: APPLICATIONS FROM LONG-TERM STUDIES

October 13-14, 1993. 90 participants.

A 2-day field tour of OSU's McDonald Research Forest and a number of Coast Range sites where COPE research projects are installed. Coordinated by Bill Emmingham of Adaptive COPE and sponsored by Western Forestry and Conservation Association, OSU College of Forestry, and Adaptive COPE.

THE ECOLOGY AND MANAGEMENT OF OREGON COAST RANGE FORESTS: A MID-TERM COPE SYMPOSIUM

March 29-31, 1994. Salishan Lodge, Gleneden Beach, Oregon. 250 participants.

A major 3-day symposium showcasing all aspects of research on forests of the Oregon Coast Range. Broad topics included the ecology of streams, riparian zones, and upslope areas; stream ecosystem restoration; silviculture and plant ecology; wildlife responses; and landscape and community perspectives. The second day closed with a panel discussion on future possibilities for management in Oregon's Coast Range forests. On the third day, participants visited COPE study sites in the Schooner Creek area and also toured the Cascade Head Experimental Forest.

The Ecology and Management of Oregon Coast Range Forests: A Mid-term COPE Symposium

PROGRAM HIGHLIGHTS

First day
Keynote address:
George W. Brown, Dean, College of Forestry

Riparian-zone Ecology and Management

Terrestrial riparian ecology:
Moderator, **Michael Adam**, Adaptive COPE

Aquatic ecology:
Moderator, **Kathleen Maas**, Adaptive COPE

Trends in aquatic communities in Coast Range streams: Moderator, **Paul Adams**, OSU Department of Forest Engineering

Terrestrial systems:
Moderator, **Gabe Tucker**, OSU Department of Forest Resources

Second day
Stream ecosystem restoration:
Moderator, **Arne Skaugset**, Adaptive COPE

Upslope Ecology and Management

Silviculture and plant ecology:
Moderator, **Bill Emmingham**, Adaptive COPE

Wildlife:
Moderator, **Nobuya Suzuki**, Adaptive COPE

Landscape and community perspectives:
Moderator, **Steve Hobbs**, COPE program manager

Perspectives and directions for the management of Oregon Coast Range forests—a panel discussion:
Moderator, **John Hayes**, Adaptive COPE

Third day
Field tour of the Schooner Creek area and the Cascade Head Experimental Forest

REGIONAL COUNCIL ON SILVICULTURAL ALTERNATIVES

May 17-20, 1994. H.J. Andrews Experimental Forest. 50 participants.

A 3-day workshop and field tour, sponsored by Cascade Center for Ecosystem Studies and Adaptive COPE.

ECOSYSTEM MANAGEMENT WORKSHOP: DISTURBANCE REGIMES AND MANAGEMENT STRATEGIES

July 18-21, 1994. H.J. Andrews Experimental Forest. 65 participants.

A 3-day workshop for professional land managers, sponsored by Cascade Center for Ecosystem Studies and Adaptive COPE.

PRESENTATIONS

Connolly, P.J. 1994. The long term response of resident cutthroat trout to forest harvest. Presented at the graduate student symposium, OSU Department of Biology, February 13, Hatfield Marine Science Center, Newport; at the annual meeting of the American Fisheries Society, Oregon chapter, February 18, Sunriver, Oregon; and at Ecology and Management of Oregon Coast Range Forests: A Mid-term COPE Symposium, March 29-31, Gleneden Beach, Oregon.

Dent, E., A. Skaugset, D. Bateman, and P. Connolly. 1994. The effect of woody debris size and orientation on aquatic habitat in Coast Range headwater streams. Presented at Ecology and Management of Oregon Coast Range Forests: A Mid-term COPE Symposium, March 29-31, Gleneden Beach, Oregon.

Emmingham, W.H., and K. Maas. 1994. Survival and growth of conifers released from alder dominated coastal riparian zones. Presented at the annual meeting of the Northwest Science Association, March 24-25, Ellensburg, Wash.

Emmingham, W.H., K. Maas, and G.F. Tucker. 1994. Survival and growth of conifers underplanted or released in alder dominated coastal riparian zones. Presented at Ecology and Management of Oregon Coast Range Forests: A Mid-term COPE Symposium, March 29-31, Gleneden Beach, Oregon.

Hayes, J.P. 1993. Spatial and temporal variation in bat activity in echolocation monitoring studies. Given at the 23rd annual North American Symposium on Bat Research, October 16, University of Florida, Gainesville.

Hayes, J.P. 1993. Research on bat populations in the Coast Range. Given at the Hatfield Marine Science Center Seminar Series, December 8, Newport, Oregon.

Hayes, J.P. 1994. Scientific considerations in natural resource management. Lecture given for students in OSU course, Natural Resources and Community Values (Anth. 481-581), April 5, Corvallis, Oregon.

Hayes, J.P. 1994. Methods for studying bat populations. Laboratory conducted for students in OSU course, Wildlife Techniques (FW 255), May 16, Corvallis, Oregon.

Hayes, J.P. 1994. A new study on the influence of commercial thinning on wildlife populations and stand structure (J.P. Hayes and W.H. Emmingham, authors). Presented at the Regional Council on Silvicultural Alternatives, May 17, H.J. Andrews Experimental Forest.

Hayes, J.P. 1994. Commercial thinning and wildlife populations. Presented at a field tour for members of Oregon Small Woodlands Association, Washington County chapter, June 11, Stimson Lumber Company lands, Washington County, Oregon.

Hayes, J.P. 1994. Temporal variation in bat activity and its importance in the design of echolocation monitoring studies (J.P. Hayes and P. Hounihan, authors). Presented at the 75th annual meeting of the American Society of Mammalogists, June 22, Smithsonian Institution, Washington, D.C.

Hayes, J.P. 1994. Commercial thinning and wildlife populations. Presented at a field tour for OSU administrators and timber industry representatives present at OSU Educator's Day, August 3, Stimson Lumber Company lands, Washington County, Oregon.

Hayes, J.P. 1994. Perspectives on biodiversity. Presented at OSU Forestry Extension's Ecosystem Management Forum, August 9, Peavy Arboretum, Corvallis, Oregon.

Hayes, J.P., and P. Hounihan. 1994. Research on bat populations in riparian areas of the Oregon Coast Range. Presented at Ecology and Management of Oregon Coast Range Forests: A Mid-term COPE Symposium, March 29-31, Gleneden Beach, Oregon.

Hayes, J.P., W.H. Emmingham, C. Smith, S.D. Hobbs, R.G. Anthony, N. Suzuki, M. Adam, and W.C. McComb. 1994. The influence of commercial thinning on wildlife populations and stand structure. Poster presented at Ecology and Management of Oregon Coast Range Forests: A Mid-term COPE Symposium, March 29-31, Gleneden Beach, Oregon.

Lavender, D.P., and W.H. Emmingham. 1994. Comparing growth of Douglas-fir (*Pseudotsuga menziesii* [Mirb. Franco]) and red alder (*Alnus rubra* [Bong.]) in a mixed cluster plantation with standard grid plantations. Presented at the annual meeting of the Northwest Science Association, March 24-25, Ellensburg, Wash.

Maas, K., and W.H. Emmingham. 1994. Establishment and growth of conifers under existing riparian vegetation in the Oregon Coast Range. Presented at the annual meeting of the Northwest Science Association, March 24-25, Ellensburg, Wash.

Maas, K.G., and W.H. Emmingham. 1994. Rehabilitation of hardwood dominated riparian areas: underplanting and release of conifers. Poster presented at the Society of American Foresters/Canadian Institute of Forestry convention, September 18-22, Anchorage, Alaska.

Skaugset, A., L. Kellogg, S. Pilkerton, and M. Miller. 1993. Active riparian area management research project: overview and update. Presented at Western Forestry and Conservation Association field tour, October 13-14, Corvallis, Oregon.

Skaugset, A.E., and R. Beschta. 1994. Riparian protection and riparian area or stream enhancement. Presented at field tour sponsored by Oregon Department of Forestry, June 21, Veneta, Oregon.

Skaugset, A.E., E. Dent, D. Bateman, M. Newton, J. Walsh, E. Cole, L. Kellogg, S. Pilkerton, M. Miller, and B. Stringham. 1994. Active riparian area management: effect on forest resources. Poster presented at Ecology and Management of Oregon Coast Range Forests: A Mid-term COPE Symposium, March 29-30, Gleneden Beach, Oregon; and at Advanced Technology in Forest Operations: Applied Ecology in Action, 17th annual meeting of the Council on Forest Engineering, July 24-29, Portland and Corvallis, Oregon.

Tucker, G.F., S.R. Johnston, W.H. Emmingham, and S.L. Garman. 1994. Silviculture for enhancing structural diversity of young forests: a controlled experiment and simulations of future stand development. Presented at Ecology and Management of Oregon Coast Range Forests: A Mid-term COPE Symposium, March 29-30, Gleneden Beach, Oregon.

CONSULTATION

Adaptive COPE's location in Newport means staff members have ready access to Coast Range resource managers. This leads to informal contacts that provide an important and effective way of exchanging information. Throughout COPE's seventh year, Adaptive COPE team members have participated in many informal discussions, field trips, and impromptu meetings. These contacts will continue to be a significant part of the Adaptive COPE goal of transferring information among researchers, managers, and the general public.

ADAPTIVE COPE SCIENTIFIC STAFF

Bill Emmingham, Adaptive COPE's silviculturist, earned a doctorate in forest ecology from OSU in 1974. He joined the Adaptive COPE team in 1993. He is interested in the ecology and management of Pacific Northwest forests, including silvicultural systems, regeneration, density management, and agroforestry. He holds an appointment as associate professor in the Department of Forest Science, where he is responsible for continuing-education and Extension programs.

John Hayes, Adaptive COPE's wildlife ecologist, earned a doctorate in ecology and evolutionary biology from Cornell University in 1990. He joined the Adaptive COPE team in 1992. He is interested in the ecology of terrestrial vertebrates in the Pacific Northwest, genetics, conservation biology, and biostatistics. He holds an appointment as assistant professor in the Department of Forest Science at OSU.

Arne E. Skaugset, Adaptive COPE's forest hydrologist, has been with the Adaptive COPE team since 1988. He earned a master's degree in forest hydrology at Oregon State University in 1980 and is now a doctoral candidate in forest engineering at OSU, with a major in forest hydrology and a minor in geotechnical engineering. He is interested in riparian-zone/stream interactions, slope stability, woody debris in streams, and active management of forested riparian zones. He holds an appointment as instructor in the Department of Forest Engineering at OSU, where he teaches undergraduate and graduate courses in Forest Engineering.

RESEARCH SUPPORT STAFF

Michael Adam joined Adaptive COPE in 1994 as a faculty research assistant. He received a bachelor's degree in wildlife biology from the University of Wisconsin-Stevens Point in 1990 and a master's degree in forestry from the University of Kentucky in 1992. His professional interests are wildlife ecology and silviculture.

Doug Bateman joined Adaptive COPE as a faculty research assistant in 1990. He received his bachelor's degree in science education from OSU in 1986. His professional interests are fisheries and silviculture.

Elizabeth Dent joined Adaptive COPE as a faculty research assistant in 1993. She received her bachelor's degree in geography from Humboldt State University in 1988 and a master's degree in forest hydrology from OSU in 1993. Her professional interests include stream-resource-related research and basin-level watershed management.

Eric Horvath joined Adaptive COPE as a faculty research assistant in 1989. He received a bachelor's degree in zoology from OSU in 1985. He left Adaptive COPE in June to pursue other interests.

Pat Hounihan joined Adaptive COPE in 1990 as a biological science research technician. His professional interests are wildlife ecology and hydrology.

Kathleen Maas joined Adaptive COPE in 1993 as a faculty research assistant. She received her bachelor's degree in botany from the University of Maryland in 1990 and a master's degree in forest ecology from Michigan State University in 1992. Her professional interests are forest ecology, silviculture, and statistics.

Vanessa Stone joined Adaptive COPE as a student worker in 1994. She is an undergraduate in Forest Engineering at OSU. Her professional interests include hydrology, fisheries, and survey statistics.

Nobuya Suzuki joined Adaptive COPE in the fall of 1993 as a graduate research assistant. He received a bachelor's degree in forest management from Shinshu University in Japan in 1985 and a master's degree in wildlife science from OSU in 1992. His professional interests include wildlife biology, biostatistics, and the influence of management activities on ecological systems.

Jennifer Weeks joined Adaptive COPE in May 1994 as a research assistant. She received her bachelor's degree in wildlife management from Humboldt State University in 1994 and will begin a master's degree at OSU in the Department of Forest Science this fall. Her professional interests include avian biology and the relationship between forest structure and bird distribution and abundance.

PLANS FOR FISCAL YEAR 1995

RESEARCH

- Continue work on the studies listed in this Annual Report.

EDUCATION

- Publish four issues of the *COPE Report.*
- Prepare a manuscript on the results of a survey of land managers on the subject of forest road drainage.
- Sponsor a field workshop featuring the newly initiated Tillamook silviculture and wildlife study.
- Sponsor a workshop on using cable logging systems to alter aquatic habitats by placing woody debris in streams.
- Publish a research paper by John Hayes on genetic considerations for landscape management.
- Continue consultations, field trips, and meetings with cooperators and the public.
- Continue to work closely with resource managers through office visits and field tours.
- Produce an Adaptive COPE Annual Report for fiscal year 1995.

ADAPTIVE COPE BUDGET SUMMARY

Expenditures	FY 94 (actual)	FY 95 (projected)
Personnel (salaries, wages, and OPE)	$419,700	$394,000
Services and Supplies	58,300	75,000
Travel	51,300	65,000
Capital Costs (equipment, facilities)	9,700	7,500
Indirect Costs	20,000	26,000
Tuition Costs	0	0
Total	**$559,000**	**$567,500**

Revenues	FY 94 (actual)	FY 95 (requested)
NBS/BLM	$144,000	$151,000
National Forests	100,000	100,000
Industry	138,700	150,000
Oregon Department of Forestry	80,000	80,000
Counties	27,500	27,500
Oregon Department of Fish and Wildlife	5,000	5,000
Oregon Small Woodlands Association	300	300
U.S. Fish and Wildlife Service	5,000	5,000
Bureau of Indian Affairs	5,000	5,000
City of Newport	1,000	1,000
Carryover	221,400	168,900
Total	**$727,900**	**$693,700**

Errata 11/21/94

ADAPTIVE COPE BUDGET SUMMARY

Expenditures	**FY 94 (actual)**	**FY 95 (projected)**
Personnel (salaries, wages, and OPE)	$419,700	$379,000
Services and Supplies	58,300	75,000
Travel	51,300	65,000
Capital Costs (equipment, facilities)	9,700	7,500
Indirect Costs	20,000	26,000
Tuition Remission	0	0
Total	$559,000	$552,500

Revenues	**FY 94 (actual)**	**FY 95 (requested)**
NBS/BLM	$144,000	$151,000
National Forests	100,000	100,000
Industry	138,700	150,000
Oregon Dept. of Forestry	80,000	80,000
Counties	27,500	27,500
Oregon Dept. Fish & Wildlife	5,000	5,000
Oregon Small Woodland Assoc.	300	300
U.S. Fish & Wildlife	5,000	5,000
Bureau of Indian Affairs	5,000	5,000
City of Newport	1,000	1,000
Carryover	221,400	168,900
Total	$727,900	$693,700

APPENDIX

COPE REPORT

This is a free newsletter highlighting COPE research activities, forthcoming educational opportunities, and recent publications and topics of interest. To receive it, write or phone:

Adaptive COPE Program
Hatfield Marine Science Center
2030 S. Marine Science Drive
Newport, Oregon 97365-5296
(503) 867-0220

COPE Report

Coastal Oregon Productivity Enhancement Program

Promoting Integrated Management of Oregon's Coast Range Forests Through Research and Education

Volume 6, Number 3 October 1993

From the Program Manager

In this issue of the COPE Report there should be something of interest for just about everyone. Featured articles include a progress report on a riparian reforestation study, a summary of winter precipitation patterns, the results of a study that examined the effects of commercial thinning on bird communities, and an overview of a stream survey program developed by the Oregon Department of Fish and Wildlife that has broad applicability. The diversity of these articles reflects the complexity of issues we face in managing the many and varied resources of the Oregon Coast Range.

As I read the articles on riparian reforestation and the effects of commercial thinning on bird communities, I was reminded of the fact that there is a great deal we can do silviculturally to achieve specific stand structures, with the objective of enhancing other resources. For example, many coast stream riparian areas are dominated by red alder and an understory of salmonberry with very little, if any, conifer or hardwood regeneration. The concern is that once the alder overstory becomes overmature and starts to deteriorate, salmonberry will become dominant and continue to effectively exclude tree species. The net result is the loss of vegetation structural diversity, future sources of large woody debris for fish habitat, and vegetation complexity for wildlife. As a result of COPE research, we now realize that in order to achieve desired levels of tree regeneration in these areas in a reasonable amount of time, active management of riparian vegetation will be necessary. This means that short-term disturbances will be required to achieve long-term improvements in fish and wildlife habitat suitability. I am convinced that this can be accomplished in an environmentally responsible way.

Silvicultural operations can be used to enhance fish and wildlife habitat, but important questions remain to be answered, not the least of which concern spatial and temporal issues. For example, over how much of the landscape and how often should different types and intensities of silvicultural operations occur to meet management objectives? We have made significant progress toward answering these questions, but there is still a lot of work to do.

Steve Hobbs

Steve Hobbs

IN THIS ISSUE

COPE Report

This issue of the COPE Report was prepared by Gretchen Bracher, Skye Etessami, John Hayes, Kathleen Maas, Arne Skaugset, Judy Starnes, and Gabe Tucker. The COPE Report is produced quarterly as a contribution of Adaptive COPE. Because of space limitations, articles appear as extended abstracts. Results and conclusions may be based on preliminary data or analysis. Readers interested in learning more about a study should contact the principal investigator or wait for formal publication of more complete results. Comments and suggestions concerning the content of the COPE Report are welcomed and encouraged. To receive this free newsletter, or for information about Adaptive COPE, contact Adaptive COPE, 2030 S. Marine Science Dr., Newport, OR 97365, (503) 867-0220. For specifics on the overall COPE Program, contact Steve Hobbs, COPE Program Manager, Forestry Sciences Laboratory, 3200 SW Jefferson Way, Corvallis, OR 97331, (503) 750-7426.

The COPE Program is a cooperative effort between Oregon State University's College of Forestry, the USDA Forest Service, Pacific Northwest Research Station, the USDI Bureau of Land Management, other federal and state agencies, forest industry, county governments, and the Oregon Small Woodland Association. The intent of the program is to provide resource managers and the public with information relative to the issues and opportunities associated with the management of fish, timber, water, wildlife, and other resources of the Oregon Coast Range. The COPE Program emphasizes an integrated approach—an integration of research and education and an integration of scientific disciplines—to find effective ways to manage these diverse resources collectively.

The COPE Program has two related components: Fundamental COPE and Adaptive COPE. Comprised of OSU and PNW scientists based primarily in Corvallis, Fundamental COPE addresses problems related to riparian zone management and reforestation in the Coast Range through basic research. Adaptive COPE is comprised of an interdisciplinary team responsible for applying and adapting new and existing research information to solve specific management problems. Stationed on the coast in Newport at the Hatfield Marine Science Center, the Adaptive COPE team is also responsible for providing continuing education opportunities to facilitate technology transfer.

ADAPTIVE COPE

SUMMARY OF 1993 WATER YEAR WINTER PRECIPITATION

From 1989 to 1990 a network of tipping bucket rain gauges was installed in the Oregon Coast Range. There are currently 14 gauges in service, spanning approximately 60 miles from north to south and 17 miles from east to west (Figure 1). Here I summarize winter precipitation (October 1992-March 1993) for the 1993 water year and contrast 1993 to winters of previous water years.

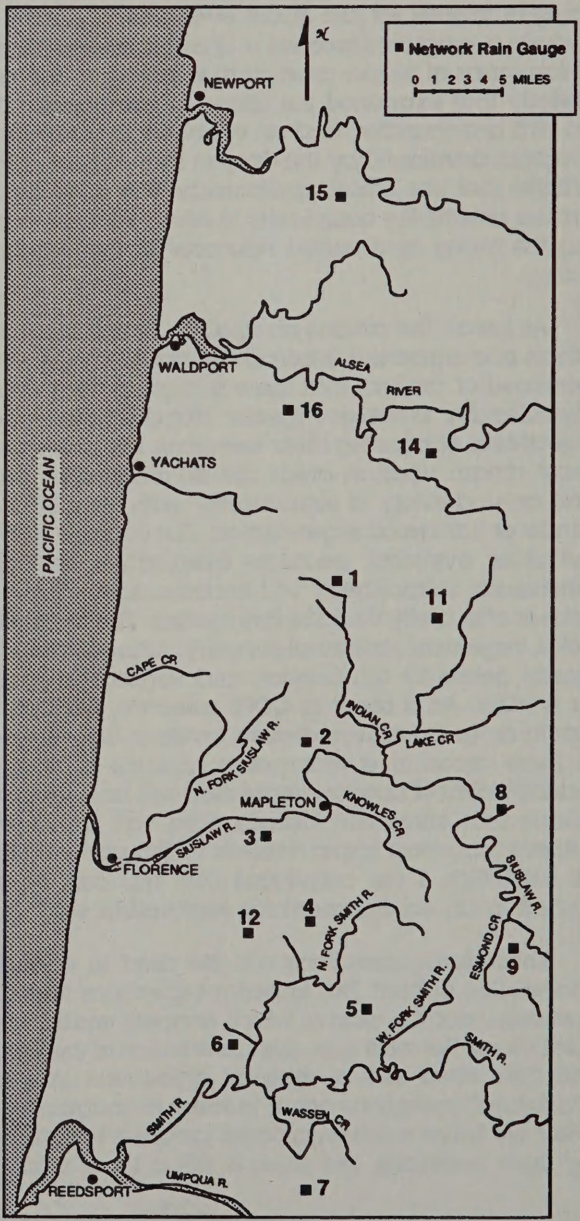

Figure 1. Locations of network rain gauges.

The 1993 average winter precipitation for gauges in service since 1989 (gauges 1-9) was 56.84 inches (Figure 2).

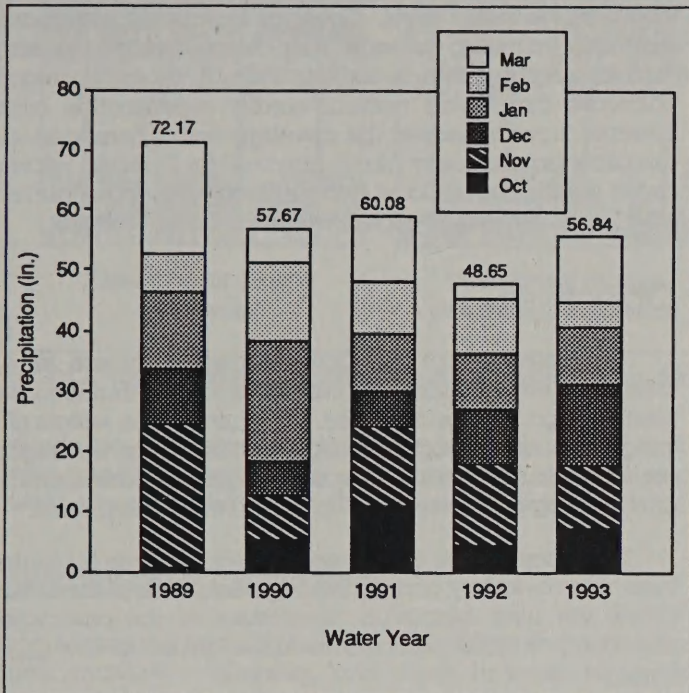

Figure 2. Average winter precipitation recorded at network rain gauges, 1989-1993.

Although this is 8.19 inches greater than 1992 winter rainfall, it is still 4.7 percent less than average winter precipitation for water years 1989-1992.

Average precipitation for the month of February was 4.25 inches, making it the driest February since the gauges have been in service. In addition, the only month to receive less rainfall over the period of record was March of 1992. December, March, and November received the highest rainfall, 13.73, 11.29 and 10.74 inches, respectively. It should be noted that precipitation in the form of snow is mostly unaccounted for with the tipping bucket rain gauges.

Variability in total winter rainfall for individual stations ranged from 77.40 inches at gauge 1 to 41.48 inches at gauge 7 (Table 1). These amounts ranged from 17.91 percent less than to 5.43 percent greater than the 1989-1991 average. The average for all 14 stations was 56.10 inches with a standard deviation of 10.14 inches.

Storms during the months of November and December were generally of high duration and low intensity, interspersed with no more than 2 to 3 day periods with little or no rainfall. Antecedent conditions for the largest storms were often wet, averaging 0.33 inches and ranging from 0 to 2.04 inches in the 24-hour period preceding the storm (Table 2). Total precipitation per storm ranged from 0.92 to 5.84 inches and intensities ranged from 0.03 to 0.18 inches per hour.

Table 1. Monthly precipitation: October 1992 - March 1993.

	Precipitation (inches)						Oct.-Mar. 92/93 total	Winter 89-91 average	% diff.
Gauge	Oct.	Nov.	Dec.	Jan.	Feb.	March			
1	9.24	14.12	17.88	12.32	5.08 [m]	18.76 [m]	77.40	84.19	-8.07
2	13.44	12.24	13.52	4.04	6.16 [m]	7.52 [m]	56.92	63.76	-10.73
3	6.32	11.48	14.52	9.72	4.00 [e]	13.04 [m]	59.08	62.55	-5.55
4	7.72	13.56	17.60	14.28	5.20 [m]	15.28 [m]	73.64	76.26	-3.44
5	6.32	9.32	14.40	9.12	3.32	10.48 [e]	52.96	51.07	3.70
6	6.16	9.60	15.48	9.24	4.08	12.00 [m]	56.56	55.86	1.25
7	5.20	9.44	6.16	11.28	4.72	4.68	41.48	50.53	-17.91
8	5.15 [m]	8.03 [m]	10.32 [m]	7.35 [m]	2.52 [m]	9.87 [m]	43.24	44.86	-3.61
9	6.00 [m]	8.85 [m]	13.68 [m]	8.66 [m]	3.15 [m]	9.96 [m]	50.30	47.71	5.43
11	7.56	11.80	15.16	10.80	3.70 [e]	14.50 [m]	63.52	N	
12	5.92	11.00	14.76	10.28	5.70 [e]	11.30 [m]	58.96	N	
14	7.80	8.76	6.00	9.04	2.52	9.28	43.40	N	
15	5.48	12.48	13.40	8.88	2.44	13.80	56.48	N	
16	5.96	11.44	11.84	8.40	2.96	10.92	51.52	N	
Avg.	7.02	10.87	13.19	9.53	3.97	11.53	56.10		
St. Dev.	2.10	1.82	3.46	2.29	1.19	3.36	10.14		
C.V.	0.30	0.17	0.26	0.24	0.30	0.29	0.18		

[e] - 1/3 or less of monthly amount estimated from other gauges.
[m] - More than 1/3 of monthly amount estimated from other gauges.
N - Station not in service over entire period.

Table 2. Precipitation amount and intensity for selected storms, October-March 1993.

Dates	Gauge	Total ppt. (in)	Storm duration (hrs)	1 hr max (in)	6 hr max (in)	24 hr max (in)	Avg. intens. (in/hr)	Antecedent 24 hr (in)
Nov.								
20-21	1	4.52	25.63	0.52	2.24	4.44	0.18	0.20
	2	0.92	34.08	0.12	0.32	0.52	0.03	0.00
	3	2.36	23.92	0.32	1.00	2.36	0.10	0.44
	4	3.52	36.60	0.44	1.28	3.00	0.10	0.44
	5	2.36	26.70	0.28	0.96	2.32	0.09	0.28
	7	2.68	43.70	0.16	0.80	1.84	0.06	0.08
	11	3.60	29.80	0.32	1.60	3.24	0.12	0.36
	12	2.20	32.10	0.28	0.76	2.12	0.07	0.32
	14	2.48	29.00	0.24	1.04	2.36	0.09	0.32
	15	3.64	26.00	0.40	1.48	3.52	0.14	0.36
	16	3.48	34.70	0.52	1.60	2.96	0.10	0.20
Jan.								
19-20	1	5.16	29.35	0.48	1.60	4.96	0.18	0.12
	3	4.04	27.53	0.40	1.60	3.96	0.15	0.08
	4	4.64	31.40	0.44	1.32	4.52	0.15	0.00
	5	3.12	30.40	0.32	1.20	3.04	0.10	0.04
	6	3.48	26.58	0.36	1.56	3.40	0.13	0.00
	7	2.76	25.00	0.28	1.20	2.72	0.11	0.04
	11	4.28	28.30	0.44	1.24	3.88	0.15	0.04
	12	4.24	27.40	0.40	1.20	4.04	0.15	0.04
	14	3.44	26.90	0.36	1.36	3.28	0.13	0.04
	15	3.16	25.70	0.36	1.00	3.12	0.12	0.04
	16	3.88	33.30	0.48	1.44	3.52	0.12	0.04

Liz Dent,
Adaptive COPE

FUNDAMENTAL COPE

REGENERATION OF COASTAL RIPARIAN AREAS: SECOND YEAR TREE PERFORMANCE

Regeneration of conifers in riparian areas is vital to the development and restoration of woody structure for the maintenance of fish and wildlife species. Although diversity of riparian areas must be addressed at the watershed level, opportunities to restore vegetative diversity in riparian areas occur at the stand level. Changes in natural disturbance patterns, including impacts from homesteading, grazing, and logging practices, in conjunction with the lack of woody substrate that favors natural conifer regeneration along streams, have increased the development of homogeneous red alder/salmonberry plant communities in many riparian areas of the Oregon Coast Range. These growing conditions often exclude conifer regeneration in riparian areas.

Objectives

The objectives of this COPE-funded study are to: (1) determine key physical and biological factors that limit tree regeneration in riparian areas, (2) evaluate the effects of a range of overstory and understory treatments on tree regeneration , and (3) assess the response of grasses, herbs, shrubs, and existing overstory trees to silvicultural treatments.

This report focuses on the second-year response of planted trees to the overstory and understory treatments at the Indian Creek site near Mapleton. Responses of the associated understory will be reported in future issues of the COPE Report.

Experimental Approach and Methods

The physical diversity (topography, soils, and geomorphology) of riparian landscapes imposes unique challenges on the design of experiments. Traditional treatment-focused experimental approaches center on assessing the response of trees to a silvicultural treatment. These require numerous study installations replicated across the riparian landscape to account for within-site differences in physical and biological characteristics. Such an approach would be logistically difficult to accomplish because of constraints on the use of public lands. Furthermore, unless replicated extensively across the landscape, such an approach would yield results with limited applications. In an attempt to circumvent these problems, this study was designed to focus on the interactions of vegetation and growing conditions by integrating and measuring plant growth and biological and physical processes affected by the management treatments.

Study plots were established during 1991 and 1992 on two riparian sites with overstories dominated by red alder, 26 and 48 years old. The study sites are located on Indian Creek in the Siuslaw River drainage near Mapleton and on Elk Creek in the Nestucca River drainage.

The study treatments were arranged in a split plot factorial design (Figure 1), consisting of six tree species planted under combinations of overstory retention and understory removal. The six planted tree species are Douglas-fir, grand fir, red alder, Sitka spruce, western hemlock, and western redcedar. The trees were all protected from browsing with vexar tubing. Overstory treatments included complete retention of the existing overstory canopy, partial retention (to attain exposure of 60 percent of full sunlight), and no retention of the existing overstory canopy. Three understory treat-

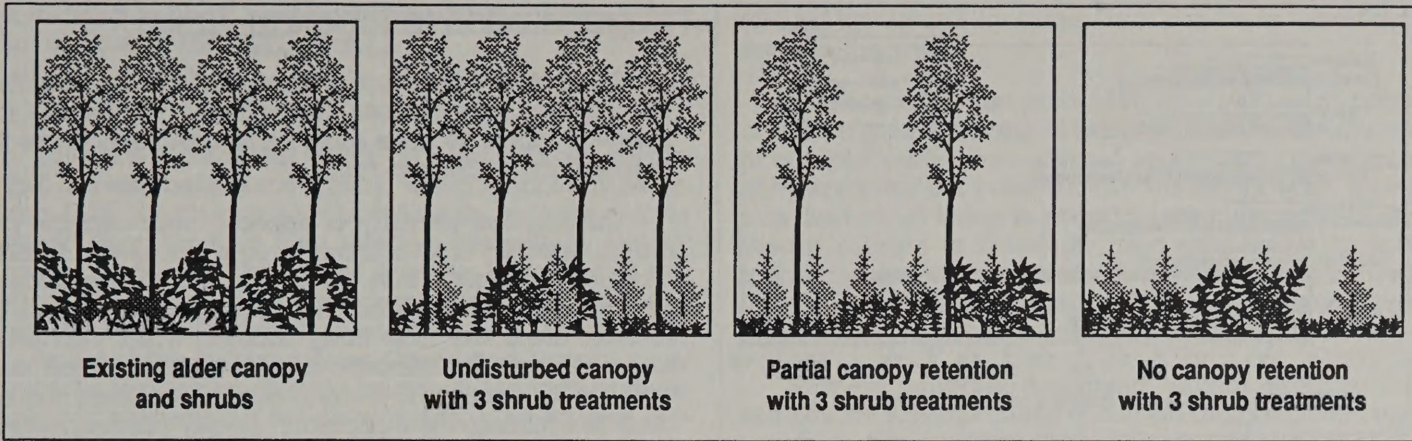

Figure 1. The response of six tree species was evaluated under different combinations of understory and overstory retention.

ments (no understory cut, understory cut annually in June, and understory cut during June and August each year) were superimposed within the overstory treatments.

Results and Discussion

Microsite variability is high in riparian areas. Soil texture, moisture availability, and depth to water table can vary substantially within meters. For example, soil texture was highly variable over an evenly spaced sampling grid in a 30 X 150 m plot located at the Indian Creek site (Table 1). Soil texture ranged from loamy sand to silty clay loam within a few meters.

Table 1. Distribution of soil textures sampled in an evenly spaced grid over a 30 X 150 m plot at the Indian Creek site.

Site	Soil texture classification
1	Loam
2	Silt loam
3	Clay loam
4	Loam
5	Silty clay loam
6	Loam
7	Silty clay loam
8	Silt loam
9	Silty clay loam
10	Loam
11	Loam
12	Sandy loam
13	Loam
14	Loam
15	Loam
16	Loamy sand
17	Loam
18	Sandy loam

In the undisturbed forests, light penetrating through the overstory usually averaged less than 10 percent of full sunlight. Gaps in the overstory red alder canopy did occur. However, these gaps were occupied by herbs and woody shrubs creating even lower light conditions near ground level.

Conifer survival after 2 years ranged from 75 to 100 percent (Figure 2). Except for western redcedar and Sitka spruce, survival of underplanted trees was generally lower under complete overstory retention. Sitka spruce had the highest and most consistent survival across all overstory treatments (over 90 percent). Survival of western redcedar was very high in the undisturbed and partial overstory treatments (97 to 99 percent), but decreased to approximately 75 percent where no overstory was retained. Survival of western hemlock decreased in direct proportion to

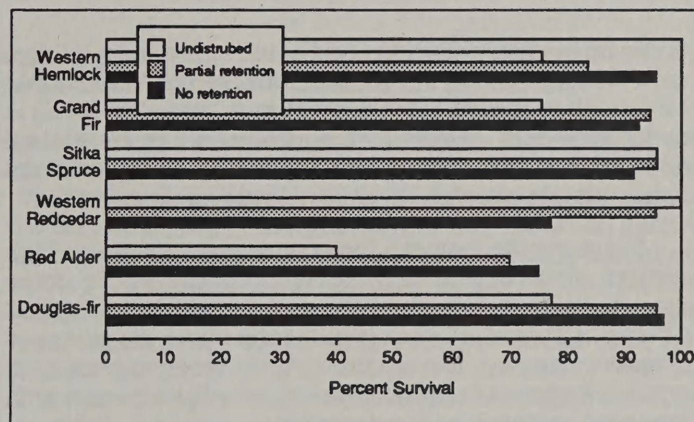

Figure 2. Second year survival of trees planted at the Indian Creek site in response to different levels of overstory retention.

the degree of canopy retention. Grand fir, red alder and Douglas-fir showed no differential survival between partial retention and no overstory canopy retention treatments.

Tree growth decreased substantially with overstory retention (Figure 3). Stem diameter relative growth rate is expressed as centimeters of new stem growth per centimeter of existing stem per year (cm/cm/yr). The use of relative growth rates minimizes the bias associated with comparing the relative performance of very large trees and smaller trees and allows for a more objective evaluation of treatment effects on different tree species.

For all species, relative tree growth decreased with increasing canopy retention. The stem diameter relative growth rates of trees planted in the undisturbed overstory canopy were often only one-third that of trees growing under no canopy retention. Trees growing under a partial overstory retention had relative growth rates twice that of trees under an undisturbed overstory and between one-half to two-thirds of trees planted under no overstory canopy retention.

Despite large differences in absolute tree sizes, the differences in relative growth rates among species were not large. Among the six tree species, only red alder growing

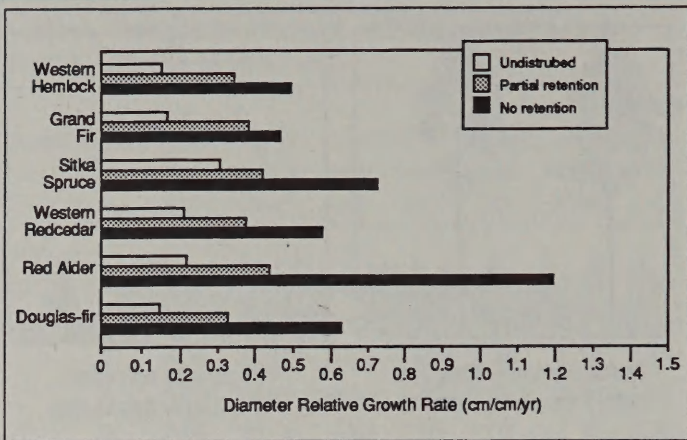

Figure 3. Second year stem diameter relative growth rates in response to different levels of overstory retention.

under no overstory retention had much higher stem relative growth rates. Among the conifers, Sitka spruce had the best stem relative growth rates performance across all levels of understory and overstory. The performances of western hemlock and Douglas-fir were similar, but Douglas-fir had better growth rates under a completely open condition.

Initial results indicate that conditions that favor high survival do not necessarily favor good growth for some species. For example, western redcedar had the highest survival but also the lowest growth rates under the complete overstory retention. Though tree survival was generally high across the range of overstory levels, growth decreased with increased retention of the overstory.

Removal of the overstory stimulated understory shrub and herb development (Figure 4). Red alder performed poorly in response to the removal of the shrub component; we attribute this to the stimulated herb growth and expect the phenomenon to be short-lived. Douglas-fir, Sitka spruce, and western hemlock responded favorably to frequent and intensive understory removal. Western redcedar and grand fir grew best where the understory was removed less intensively.

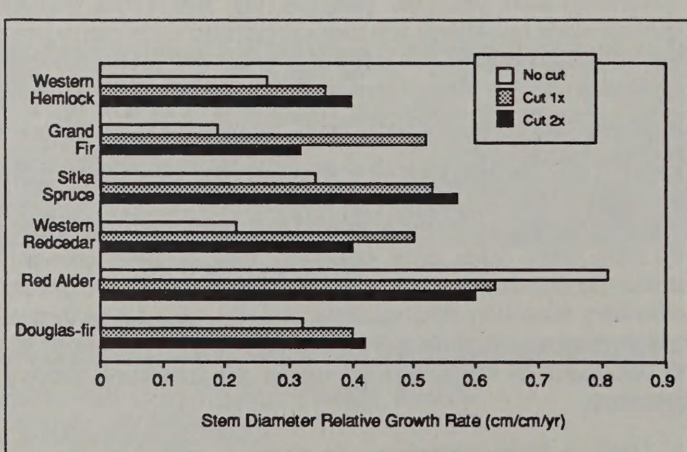

Figure 4. Second year stem diameter relative growth rates in response to different levels of understory retention.

Regeneration in Riparian Areas

The preliminary nature of these results do not permit us to infer strong conclusions. Nevertheless, we believe the observed trends do have some immediate implications for regeneration in riparian areas.

The physical diversity of riparian areas and the dynamic response of vegetation to changes in the riparian environment dictate that we avoid blanket regeneration prescriptions across a landscape. Regeneration of trees in riparian areas will most likely succeed when vegetation and variations in microsite factors are considered and matched to management objectives. This will likely require an active management approach. Simply planting trees in red alder/salmonberry riparian areas without some form of manipulation to the overstory and understory is unlikely to succeed. In addition, our results suggest that active management should include monitoring of both survival and growth. Additional understory treatments are likely be necessary to insure growth.

The manual understory removal treatments, though effective in reducing competition from understory shrubs, did not create growing conditions completely free from all competing vegetation. A "weed free" environment may lead to higher tree survival and growth rates than those described in this report. Tradeoffs between maximizing tree growth and the maintenance of vegetative diversity for other values should be considered.

A diverse mixture of trees, grasses, and shrubs can be established in riparian areas through treatments that improve the microsite such as an increase in the availability of light and moisture. Efforts to increase the conifer component without reducing diversity in riparian areas will require knowledge of the needs of other species for these same resources.

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OF INTEREST

BIRD COMMUNITIES IN COMMERCIALLY THINNED AND UNTHINNED DOUGLAS-FIR STANDS OF WESTERN OREGON

Editors note: *This study provides an excellent analysis of bird communities in thinned plantations using a retrospective approach. The questions addressed in this study, in conjunction with questions concerning snag creation, understory development, and influences of thinning on other species of wildlife, will be further examined in a manipulative study conducted by Adaptive COPE. The study is*

scheduled to begin next year and will be discussed in a future issue of the COPE Report.

JPH

In western coniferous forests, changes in forest structure that increase habitat complexity, whether naturally occurring (e.g., resulting from succession) or management-induced (e.g., resulting from selective harvesting), usually result in increased bird species diversity. It is assumed that structurally complex forest stands are capable of supporting diverse bird communities because they provide many potential niches for bird species. Commercial thinning may increase bird species diversity by enhancing vertical diversity in a forest stand if the development of understory vegetation is encouraged as a result of increased light levels.

The structural characteristics that result from a commercial thinning depend not only on the number of trees removed, but also on the dominance class of trees removed. Thinning from below, typical in Douglas-fir stands in the Oregon Coast Range, can decrease the depth of the canopy layer, effectively removing a vegetative layer or layers from the stand. Thus, while commercial thinning may result in the development of understory layers in a stand, it also may reduce dimensions of the overstory layers.

We compared the species richness and diversity of bird communities, as well as the abundance of selected bird species, between commercially thinned and unthinned Douglas-fir stands in western Oregon.

Methods

Study sites were located in the central Oregon Coast Ranges (CCR) in Benton and Lincoln Counties, and in the northern Oregon Coast Range in the Tillamook State Forest (TSF). We chose 4 commercially thinned and 4 unthinned stands in each region (16 total stands). Stands were 65 to 510 ha in size and dominated by Douglas-fir overstories. Unthinned stands averaged 495 trees/ha (range 322 to 724) and had an average relative density index of 0.34 (range 0.27 to 0.49). Thinned stands averaged 360 trees/ha (213 to 598), had an average relative density index of 0.24 (0.17 to 0.27), and were treated 5 to 15 years prior to sampling. Sites in the CCR were on land managed by Starker Forests, Inc., Siuslaw National Forest, and Willamina Lumber Company. Study sites located in the TSF were managed by the Oregon Department of Forestry (ODF).

Birds were counted by the senior author from early May through late June in 1989 and 1990, and during the winter from November 1989 through April 1990, using a point count method. Four randomly located points in each stand served as plot centers (a total of 64 plots). Plot centers were at least 100 m apart and at least 100 m from a stand edge. Breeding season counts were conducted from 0.5 hour before sunrise to 4 hours after sunrise on days without heavy rain or strong winds. Each plot was visited four times during breeding season counts. Winter counts were conducted from sunrise to early afternoon in all but the most severe weather. During the winter, one plot/stand/day was visited to reduce the chances of double-counting non-territorial birds as they foraged throughout the stand. Each stand was visited eight times in the winter.

Breeding bird data from 1989 and 1990 were pooled and those species having at least 28 observations within 60 m of a plot center were selected for analysis. The number of observations per stand (n = 16 stands) for each species was used as an index to abundance for all analyses. Bird species richness and diversity, and abundance for each species meeting the above criteria were compared between thinned and unthinned stands within regions and between regions using a split-plot analysis of variance (ANOVA).

Sixty-six variables describing habitat structure and composition were measured or derived at eight plots in each stand. We used multiple regression and discriminant function analysis to explore the relationships between the abundance or presence of bird species and habitat features.

Results and Discussion

Breeding bird species diversity was higher in thinned stands than in unthinned stands (Table 1), but differences in species richness and diversity of birds during the breeding season were greater between regions than between thinned and unthinned stands. Species richness, diversity and abundance were higher in the CCR than in the TSF. The number of bird species observed in a stand was positively correlated with hardwoods >30-cm dbh, conifers >56-cm dbh, and snags >52-cm dbh, and negatively correlated with the distance to a patch edge. Other studies have also found that variables describing live deciduous trees are positively related to bird species richness and bird abundance in unmanaged forests in western Oregon and Washington. Even small patches of deciduous trees can have a positive influence on densities of certain bird species in conifer-dominated plant communities. Snags provide critical habitat for a group of birds that nest in cavities and forage on dead wood. The relationship between bird species richness and distance to a patch edge represents an "edge-effect," described by many avian ecologists. The greater density of hardwoods >30-cm dbh, greater deciduous foliage cover, and the shorter average distance to a patch edge in the CCR than the TSF may have been at least partially responsible for the greater bird species richness and diversity observed in the CCR.

During the breeding season, six bird species were more abundant in thinned stands, three species were more abundant in unthinned stands (Table 1), and eight species did not differ in abundance between conditions.

Three of the species that were more abundant in thinned than unthinned stands seemed to be responding to the greater openness of thinned stands. Two of these, Hammond's flycatcher and hairy woodpecker, were consistently observed only in thinned stands. The third, red-breasted nuthatch, was more abundant in thinned stands during both the breeding and the winter seasons.

The patterns of abundance for warbling vireos and brown creepers, both more abundant in thinned than unthinned stands in the CCR, seemed to be related to habitat

Table 1. Abundance indices (number of observations per stand) of birds in 8 thinned and 8 unthinned Douglas-fir stands summed over four breeding season counts each in 1989 and 1990, Central Coast Ranges and Tillamook State Forest, Oregon. Only species with at least 28 total observations within a fixed radius plot (60 m radius) are included.

	Thinned		Unthinned		
Species	$\bar{x}$	SE	$\bar{x}$	SE	P[a]
Black-throated gray warbler	7.0	1.7	12.6	2.8	**
Brown creeper	7.2	1.7	4.9	1.5	**
Dark-eyed junco	14.9	3.6	8.5	2.6	**
Golden-crowned kinglet	16.0	1.5	23.9	1.3	**
Hairy woodpecker	3.5	0.9	0.0	0.0	**
Hammond's flycatcher	11.6	4.2	0.0	0.0	**
Pacific-slope flycatcher	24.0	4.5	30.2	3.6	*
Red-breasted nuthatch	3.6	1.0	0.9	0.5	*
Warbling vireo	10.6	3.3	8.1	1.6	**
Abundance (birds/ha)	3.7	0.3	3.2	0.2	*
Diversity	1.131	0.018	1.078	0.008	**

[a] Significance levels for differences in mean number of observations per stand between thinned and unthinned stands: *, $P < 0.10$; **, $P < 0.05$.

characteristics that were not directly related to thinning. Warbling vireo abundance was positively associated with density of hardwoods >30-cm dbh, and brown creeper abundance was positively associated with shrub and hardwood characteristics.

In contrast to the hypothesis that thinning may improve habitat for bird species associated with shrubs in forest understories by enhancing the growth of these shrubs, we found no difference in the abundance of two shrub-associated species, Wilson's warbler and Swainson's thrush, between thinned and unthinned stands. The thinnings performed on our sites were probably too light (CCR) or too recent (TSF) to show any enhancement of shrub growth. However, dark-eyed junco, a species that typically increases in abundance after harvests that reduce canopy cover, were more abundant in thinned than unthinned stands. Dark-eyed juncos forage and nest on or close to the ground and are associated with forest openings and patches of early successional vegetation, particularly herbaceous cover, in northwest forests. Herbaceous cover was greater in commercially thinned stands than unthinned stands in our study.

The three species that were more abundant in unthinned stands (Table 1) are typically associated with dense forests. Golden-crowned kinglet and Pacific-slope flycatcher abundances were both positively associated with high (>20 m above the ground) conifer cover. Pacific-slope flycatcher and black-throated gray warbler abundances were positively associated with variables describing live deciduous trees.

Scope and Limitations

The scope of our study was restricted to 40- to 55-year-old stands dominated by Douglas-fir in the two regions studied. Additional research would be needed to determine if the same patterns hold for other areas of the Oregon Coast Range, in other stand age classes, over a higher or lower range of stand densities, and in stands dominated by species other than Douglas-fir.

Time since thinning is probably an important factor influencing habitat structure and therefore bird community composition. We were unable to assess the influence of time since thinning on the results of our study because it was confounded with region effects: TSF stands generally were thinned more recently than CCR stands.

We could assess habitat relationships for only those bird species amenable to being counted. Wide-ranging or inconspicuous species, such as raptors and grouse, were observed too infrequently to permit analysis. Such species are nonetheless important members of the forest wildlife community.

Management Implications

Commercial thinning may be a valuable tool for land owners managing multiple resources. In addition to enhancing timber production, thinning has the potential to enhance habitat for some bird species in overstocked second-growth Douglas-fir stands. Hammond's flycatchers, red-breasted nuthatches, dark-eyed juncos, and winter wrens are species that were associated with commercially thinned stands in our study. These species deserve the attention of land managers because they are declining in abundance (19.5, 0.2, 1.7, and 6.6 percent per year, respectively) in Oregon according to breeding bird survey trend data. Snags and hardwoods should be considered when thinning young stands. Some bird species associated with these features, such as chestnut-backed chickadees (snags) and warbling vireos and black-throated gray warblers (hardwoods), also seem to be experiencing population declines (2.0, 1.0, and 8.2 percent per year, respectively) in Oregon.

In order to create habitat heterogeneity both within and among stands and to provide the structural features which seem to be associated with the abundance of several bird species, we suggest the following. A thinning regime that would maintain a relatively open canopy throughout the development of the stand may maximize habitat heterogeneity by allowing shrubs to be maintained in the understory. The growth of hardwoods retained in the stand also would be enhanced by the higher light levels. The enhancement of shrubs and hardwoods would favor species such as Wilson's warblers, Swainson's thrushes, and warbling vireos. Maintaining the relatively open canopy and lower stem

density also would favor Hammond's flycatchers, hairy woodpeckers, and dark-eyed juncos. However, golden-crowned kinglet and Pacific-slope flycatcher abundance would probably be lower in a stand kept open by thinning than in an unthinned stand. Black-throated gray warblers might be more abundant in an unthinned stand only if hardwoods were present. If some dense patches of trees were left unthinned within a thinned stand, then bird species diversity and richness might be further enhanced on the stand level because habitat for species preferring denser vegetation might be maintained, albeit on a small scale. Alternatively, unthinned strips or patches (approximately 8 ha per 40 ha of thinning to include the territories of the species that we sampled) could be left adjacent to thinned stands, so that the habitat needs of all of the birds that we sampled might be met among stands.

Snags could be maintained in the stand by creating them artificially, by leaving unthinned areas where competition mortality may occur, or by a combination of these strategies. Competition mortality in unthinned leave areas might provide small (< 30-cm dbh) snags, whereas trees > 30-cm dbh could be killed to provide larger snags. Thinning could accelerate tree growth, making it possible to create larger snags than might occur in an unthinned stand of the same age.

Acknowledgements. We thank the Oregon Department of Forestry, Willamina Lumber Co., Starker Forests, and the USDA Forest Service for allowing us to work on their lands. Funding was provided by the Forest Research Laboratory, Oregon State University.

Suggested Readings

Artman, V.L. 1990. Breeding bird populations and vegetation characteristics in commercially thinned and unthinned western hemlock forests of Washington. M.S. Thesis, University of Washington, Seattle. 55 p.

Balda, R.P. 1975. Vegetation structure and breeding bird diversity. Pages 59-80 in D.R. Smith, tech. coord. Proceedings, Symposium on Management of Forest and Range Habitats for Nongame Birds. USDA Forest Service, Washington, D.C. General Technical Report WO-1.

Hagar, J.C. 1992. Bird communities in commercially thinned and unthinned Douglas-fir stands of western Oregon. M.S. Thesis, Oregon State University, Corvallis. 110 p.

Hunter, M.L. 1990. Wildlife, forests, and forestry: principles of managing forests for biological diversity. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 370 p.

Medin, D.E. 1985. Breeding bird responses to diameter-cut logging in west-central Idaho. USDA Forest Service, Intermountain Research Station, Ogden, Utah. Research Paper INT-355. 12 p.

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THE OREGON DEPARTMENT OF FISH AND WILDLIFE STREAM SURVEY PROGRAM

Introduction

Stream surveys have been an integral part of fish management in Oregon for the past 100 years. The objectives and methods of the surveys have changed over time following the changing priorities and interests of the fisheries agency. In the late 1800's and early 1900's, surveys focused on single issues such as locating capture facilities for broodstock, identifying potential hatchery sites, describing barriers to upstream passage, and estimating amounts of spawning gravel. Two survey efforts in the late 1930's and 1940's were directed to overall habitat conditions in streams. One series of surveys conducted by the Oregon Game Commission focused on biotic conditions in streams relative to the potential to support hatchery fish. The second series of surveys by the U.S. Bureau of Fisheries included quantitative information on pool size for 8,000 kilometers of stream. The Fisheries Commission and Game Commission of Oregon continued surveys related to spawning gravel and rearing habitat, upstream passage problems, and overall watershed condition through the early 1970's. The physical and biological survey format was accepted as the standard survey method after the Game and Fisheries commissions merged in 1975 (see Suggested Readings). Though broadly conceived, in practice these surveys typically focused on selected fish populations, or on one aspect of the life history of a species.

As it became recognized that land-use practices have significant impacts on resident and anadromous fish populations, district fish biologists concentrated more on regulatory issues and, consequently, had less time for the field work of stream surveys. Extended over 20 years, this shift in effort resulted in a general lack of information on habitat conditions. During the same time period, many anadromous and resident fish populations declined in abundance or became more fragmented and isolated. Habitat degradation was clearly a factor in these changes, but data that documented the associated changes in habitat was absent. Also, the inapplicability of old survey methods and information to new questions and concerns was apparent. The need to address a complex and broader set of issues required a new approach to stream surveys, one that considered all aspects of habitat evaluated throughout a watershed.

Development of a new aquatic inventory project designed to provide quantitative information on habitat condition for streams throughout Oregon began within the Oregon Department of Fish and Wildlife (ODFW) in 1989. Drafting of stream survey methods and implementation of field work began in 1990. Results of the inventory are used to provide basic information for biologists and land managers, to determine limiting factors for fish populations and carrying capacity of habitat, to establish monitoring programs, and to direct or focus habitat protection and restoration efforts.

The inventory is general enough to apply a standard methodology across different ecoregions and different land-use or management regimes. The method can be integrated with other watershed activities such as temperature monitoring, water quality sampling, and fish population surveys. In addition, the methodology provides flexibility of scale so that information can be summarized at the level of micro-habitat for associations of habitat, portions of streams, watersheds, and within regions. Because the Oregon Department of Fish and Wildlife is the only agency responsible for fish in all waters of the state, it is essential that the survey protocol provide a widely applicable base of information.

The conceptual background for this work came from the research experience of project staff and from interactions with Oregon State University, forest industry, and USFS PNW research scientists. Annual review and modification of the methodology have benefited from input from ODFW and USFS biologists who have applied the results of the surveys or who are working on similar programs.

Methods

The stream survey is organized by reach and channel units. Reaches vary in length from as short as 0.5 kilometer to more than 8 kilometers and are defined by valley geomorphology, land use, riparian characteristics, and stream flow. Valley geomorphology defines the level of constraint that local landforms such as hillslopes or terraces impose upon the stream channel. The survey describes the reaches in terms of hillslope constrained, terrace constrained, and unconstrained stream channels. Within each reach, the stream is described as a sequence of habitat units. Each unit is longer than one active channel width and is an area of relatively homogeneous slope, depth, and flow pattern representing different channel forming processes. The channel can be classified into 22 hierarchically organized types of pools, glides, riffles, rapids, steps, and cascades. Surveys are conducted by walking the stream from mouth to headwaters, and the length and width of every habitat unit are estimated. At every unit, gradient, substrate, woody debris, shade, instream cover, and bank stability are recorded.

The methodology we use and the resulting data summaries are compatible with the methods and summaries used by Oregon State University and the U.S. Forest Service. This compatibility prevents a duplication of survey efforts between institutions.

Survey data from each stream are summarized in a standard format. This includes a written summary, 7.5 minute topographic maps, tabular summaries by reach and by unit type, graphical summaries by reach and by unit, and notes and comments written by the field crew during the survey. These survey summaries are used individually and in composite to determine overall stream condition and to compare current condition to historical condition. The information is also used to determine distribution of fish or size of fish populations, to estimate limiting factors or carrying capacity of stream habitat, and to set transect locations for stream flow studies. Standards can be developed from survey results for protection, desired future condition, and habitat restoration of streams in each ecoregion. Finally, analysis of inventory data can determine what land use or resource extraction activities are compatible with fish and aquatic habitat management goals.

Results and Discussion

The surveys describe conditions in a stream in the context of the watershed and the region. The following example from northwestern Oregon exemplifies the type of information that results from the survey and our analytical approach.

Wild coho salmon have become virtually extinct in tributaries to the lower Columbia River downstream of Portland. Impacts on these coho populations include long-term alteration of freshwater habitat, genetic introgression and competition from hatchery fish, and high levels of harvest. Stream surveys in these tributaries show the current status of freshwater habitat and relate the changes in habitat to landuse practices (agriculture, timber harvest, roads, and water withdrawal). Survey data can also be used to estimate the current and potential carrying capacity for coho salmon, and suggest habitat restoration opportunities. Big Creek, a tributary to the lower Columbia River, is not accessible to anadromous fish because a weir blocks passage and diverts water to a fish hatchery. We were asked to assess the potential of the current habitat upstream from the hatchery and the potential for restoration in Big Creek and its major tributaries.

Habitat surveys were conducted during both summer and winter to describe conditions over a range of flow regimes. Winter surveys are necessary to describe the amount and location of low velocity pool habitat that juvenile coho salmon require during the winter stage of their life history. These habitats are also used by steelhead and cutthroat trout. The woody debris component in the streams is also critically important to juvenile coho salmon.

The analyses included longitudinal profiles of the stream gradient (Figure 1A), location of pools deeper than 1.5 meters (Figure 1B), and location of large woody debris (Figure 1C). Geographic Information System (GIS) analysis incorporated the field data onto a digitized map layer by dynamic segmentation to provide a better description of the location of selected habitat features. For example, the location of pools with depth of 0.8 meters or more can be mapped. GIS technology allows us to combine habitat attributes, characterize them with a set of benchmarks or numerical models, and plot the location on a map.

Results for the basin documented the existence of good habitat for steelhead trout and fair habitat for coho salmon above the Big Creek Hatchery. However, rainbow trout, cutthroat trout, and sculpins were the only fish species observed. The potential of the streams in the Big Creek watershed to produce coho salmon averaged 790 smolts/km in the mainstem and 350 smolts/km in the tributaries. The uppermost reaches of Big Creek had production potential of only 250 smolts/km. However, the identification of a broad valley floor, numerous small tributaries, and abundant large woody debris on the upper floodplain, indicate excellent opportunities for habitat restoration in these reaches.

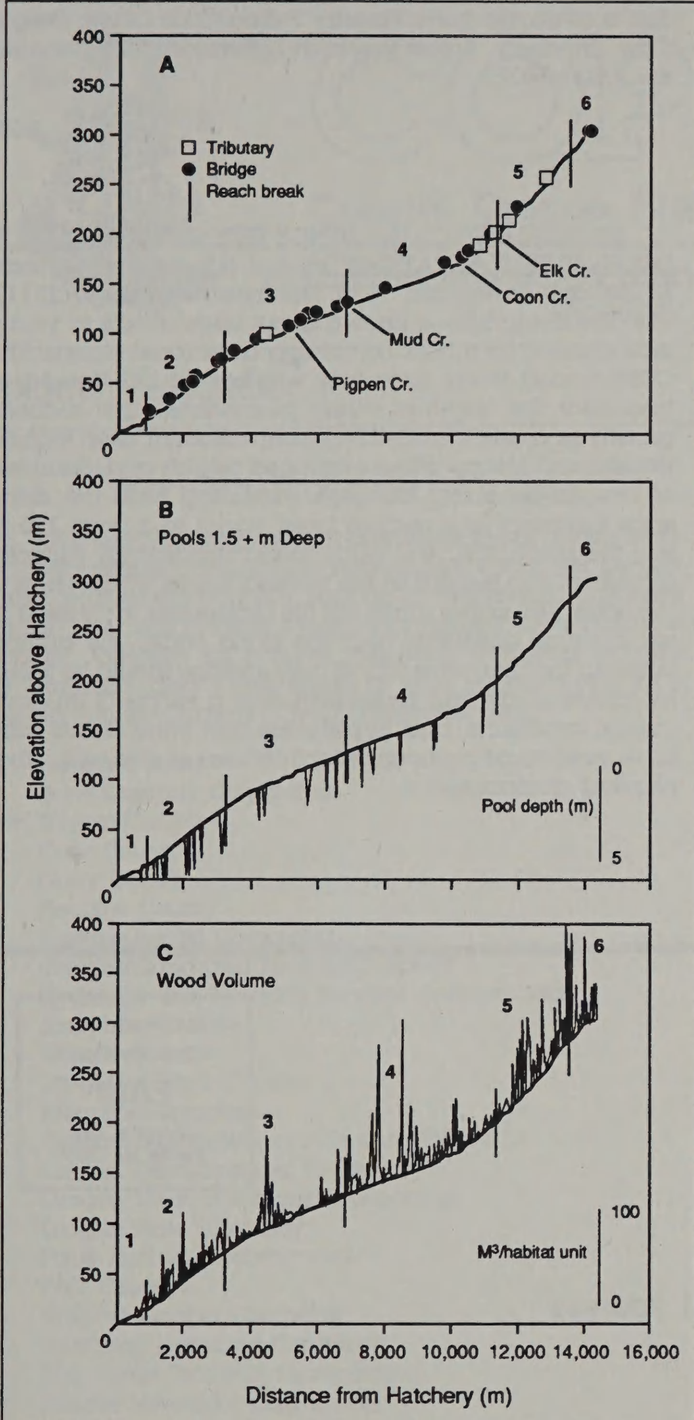

Figure 1. Some survey results from Big Creek in northwest Oregon: (A) Longitudinal profile of the stream gradient, (B) Location of pools greater than 1.5m deep, (C) Location of large woody debris.

An assessment of habitat capacity for coho salmon provides ODFW staff the technical information needed to weigh the potential for natural production of anadromous fish in Big Creek against the costs and risks associated with allowing fish passage over the hatchery weir. It also provides the information to develop a watershed restoration plan in cooperation with the private landowners in the basin.

Summary

The methods and analysis used by the Aquatic Inventories Project have wide applicability to fish and habitat management concerns. The major strength of the stream inventory process is our ability to use it to work across spatial scales of habitat and generalize at useful levels of resolution. Utilization of the data, however, has been somewhat limited because of the perceived complexity of the analysis. Application of the data has frequently been directed at special case studies such as the example described, or at specific questions, such as the relationships between land use and abundance of large woody debris within a region.

Broader application of inventory data and analysis should result from increased effort in two areas: (1) the integration of the high resolution habitat data into broad perspective watershed management plans and activities, and (2) the incorporation of the field surveys into easily accessible GIS data layers that can be merged with other data sets or satellite image analysis and become a component of ecosystem studies.

Suggested Reading

Oregon Department of Fish & Wildlife. 1977. Manual for Fish Management. Portland, Oregon.

Kim K. Jones and Kelly M.S. Moore,
Oregon Department of Fish and Wildlife

OPPORTUNITIES

From the OSU College of Forestry Conference Office:

THE ECOLOGY AND MANAGEMENT OF OREGON COAST RANGE FORESTS: A MID-TERM COPE SYMPOSIUM

March 28-30, 1994 — Salishan Lodge, Gleneden Beach, OR

This symposium will highlight our current understanding of the ecology and management of riparian and upland sites in the Oregon Coast Range. Details of the symposium will be presented in a future issue of the COPE Report.

For more information on the above conferences, contact OSU College of Forestry Conference Office, Oregon State University, Corvallis, OR 97331-5707, or Telephone (503) 737-2329, or FAX (503) 737-2668.

PUBLICATION REVIEWS

TALL PLANTING STOCK FOR ENHANCED GROWTH AND DOMINATION OF BRUSH IN THE DOUGLAS-FIR REGION by M. Newton, E.C. Cole, and D.E. White. 1993. New Forests 7:107-121. The advantages of using tall nursery stock in brush dominated areas (mainly salmonberry) are discussed in this publication. Both survival and growth of Douglas-fir and hemlock increased when tall stock was used. Release from brush, along with stock height, were important for survival and growth. Container-grown or 2+0 bare-root seedlings required 0.6 to 8 years longer to reach a height of 6 m than did large Douglas-fir transplants. Sitka spruce grew well when released from salmonberry, until injured by insects. Limitations of using taller stock are that it is bulkier and requires more storage and transportation facilities; it is more difficult for planters to carry; and, because of the possible need for root pruning, planting may need to be restricted to shady or moderately moist areas. This publication is available from: Forestry Publications Office, Oregon State University, Forest Research Laboratory 227, Corvallis, OR 97331-7401.

KGM

DO EDGE EFFECTS INFLUENCE TREE GROWTH RATES IN DOUGLAS-FIR PLANTATIONS? by A. J. Hansen, S. L. Garman, P. Lee, and E. Horvath. 1993. Northwest Science 67(2):112-116. Relatively little is known about edge effects in young plantations in a matrix containing older forest stands. This COPE-funded study examines whether young Douglas-fir trees near the edges of young plantations suffer reduced growth as a result of shading from adjacent older stands. Hansen and his coworkers examined heights and diameters of Douglas-firs along transects extending from the stand edge (adjacent to a mature forest stand) to a point 120 m into the plantation. The study found significantly reduced diameters and heights at the transect points within 20 m of the edge. The paper attributes the differences to shading or soil moisture gradients near the stand edge. The authors point out that the generality of their findings should be tested by further study and replication over a range of environmental conditions, and hypothesize that edge effects may have even more pronounced influences on sites with other physical characteristics.

JPH

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COPE Report

Coastal Oregon Productivity Enhancement Program

Promoting Integrated Management of Oregon's Coast Range Forests Through Research and Education

Volume 7, Number 1

January 1994

From the Program Manager

We should recognize that advances in our understanding of Oregon Coast Range ecosystems would not be possible without the financial support of cooperating organizations. Although diverse, these organizations share common goals: concern for natural resources; the need for new information; and a willingness to work cooperatively for a better future. Current COPE cooperators are:

Benton County
Boise Cascade Corporation
City of Newport
Coos County
Curry County
Douglas County
Georgia-Pacific Corporation
Giustina Land and Timber Company
Hydraulic and Machine Services, Incorporated
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Menasha Corporation
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Oregon Department of Forestry
Oregon Small Woodlands Association
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Steve Hobbs

IN THIS ISSUE

COPE Report

This issue of the COPE Report was prepared by Doug Bateman, Gretchen Bracher, Bill Emmingham, Skye Etessami, John Hayes, Kathleen Maas, Arne Skaugset, Judy Starnes, and Gabe Tucker. The COPE Report is produced quarterly as a contribution of Adaptive COPE. Because of space limitations, articles appear as extended abstracts. Results and conclusions may be based on preliminary data or analysis. Readers interested in learning more about a study should contact the principal investigator or wait for formal publication of more complete results. Comments and suggestions concerning the content of the COPE Report are welcomed and encouraged. To receive this free newsletter, or for information about Adaptive COPE, contact Adaptive COPE, 2030 S. Marine Science Dr., Newport, OR 97365, (503) 867-0220. For specifics on the overall COPE Program, contact Steve Hobbs, COPE Program Manager, Forestry Sciences Laboratory, 3200 SW Jefferson Way, Corvallis, OR 97331, (503) 750-7426.

The COPE Program is a cooperative effort between Oregon State University's College of Forestry, the USDA Forest Service, Pacific Northwest Research Station, the USDI Bureau of Land Management, other federal and state agencies, forest industry, county governments, the city of Newport, and the Oregon Small Woodlands Association. The intent of the program is to provide resource managers and the public with information relative to the issues and opportunities associated with the management of fish, timber, water, wildlife, and other resources of the Oregon Coast Range. The COPE Program emphasizes an integrated approach—an integration of research and education and an integration of scientific disciplines—to find effective ways to manage these diverse resources collectively.

The COPE Program has two related components: Fundamental COPE and Adaptive COPE. Comprised of OSU and PNW scientists based primarily in Corvallis, Fundamental COPE addresses problems related to riparian zone management and reforestation in the Coast Range through basic research. Adaptive COPE is comprised of an interdisciplinary team responsible for applying and adapting new and existing research information to solve specific management problems. Stationed on the coast in Newport at the Hatfield Marine Science Center, the Adaptive COPE team is also responsible for providing continuing education opportunities to facilitate technology transfer.

ADAPTIVE COPE

ACTIVE RIPARIAN ZONE MANAGEMENT PROJECT: PRELIMINARY LOGGING OPERATIONS RESEARCH RESULTS

Many riparian areas along coastal Oregon streams are dominated by hardwood overstories and shrub understories as a result of past fires, floods, and timber harvesting practices. In addition, many coastal Oregon streams, especially those running through hardwood and shrub dominated riparian zones, are woody debris poor. Active riparian zone management is an attempt to prescribe management activities that will resolve problems associated with riparian areas dominated by shrubs and hardwoods in debris-poor streams. We consider active riparian zone management to consist of two separate activities: stream enhancement and riparian silviculture. Stream enhancement is a short-term solution that entails placing large woody debris in debris-poor streams to enhance fish habitat. Riparian silviculture is a long-term approach that entails establishing conifers in riparian areas dominated by shrubs and hardwoods; these conifers will eventually become sources of large woody debris for the stream. Both stream enhancement and riparian silviculture have been prescribed and studied independently in small demonstration projects and in plot level research. They have rarely been carried out in conjunction with timber harvesting and, when they have, the projects have been neither well-described nor the subject of rigorous study.

Adaptive COPE, Fundamental COPE, and CRAFTS (Coordinated Research on Alternative Forestry Treatments and Systems) have begun a collaborative project on active riparian area management. The research project is a large, operational, manipulative study that includes both stream enhancement and riparian silviculture as an integral part of timber harvesting. The riparian silviculture component of this study is under the direction of Dr. Mike Newton, OSU Forest Science Department, as a special CRAFTS project; the stream enhancement component is being directed by Arne Skaugset of the Adaptive COPE Program; and the logging operations research component is a Fundamental COPE project under the direction of Dr. Loren Kellogg, OSU Forest Engineering Department.

Methods

The study area consists of three harvest units located on industrial forest land owned by Starker Forests, Incorporated and Menasha Corporation in the central Oregon Coast Range. The streams running through the harvest units are debris-poor. The riparian areas have alder-dominated overstories with shrub-dominated understories and lack natural conifer regeneration. The harvest unit extends along at least 2,000 feet of the main stem of each study stream. At the upstream and downstream ends of the 2,000 foot study reach, 300 foot long openings were installed (Figure 1).

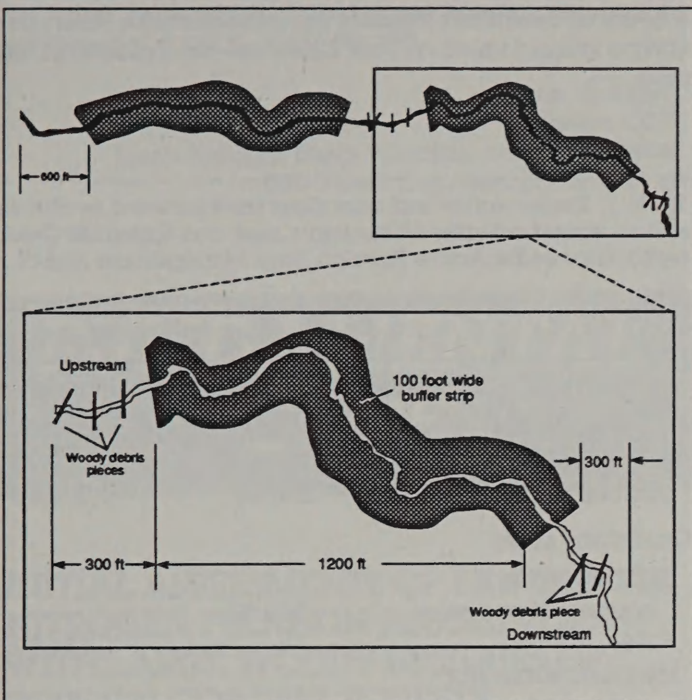

Figure 1. Layout of openings and buffer strips for each replication of the active riparian-zone management project.

Between the 300 foot openings, 100 foot wide buffer strips were left along each side of the stream. An additional 600 foot opening was cut on the stream or on an adjacent tributary.

In the riparian silviculture component of this study, three stocktypes of three conifer species will be planted in the 300 and 600 foot openings in the riparian area. The effect of opening size and the species and stocktype of seedlings on seedling survival and growth will be determined. Stream temperature and streambank disturbance from logging directly adjacent to the stream will also be monitored.

In the stream enhancement component, complex woody debris accumulations will be installed in the streams within the 300 foot openings during harvesting. The complex debris accumulations will consist of a single, large piece of wood and three to six smaller pieces of woody debris. Two types of large woody debris will be used: large conifer logs yarded from the upslope harvest unit and large alders pulled over with the root wad intact. The skyline yarding equipment available on site will be used to install both types of key debris pieces. Three debris accumulations using large conifer logs as key pieces and three debris accumulations using alders will be installed in each stream. Stream habitat surveys will be carried out and topographic maps of the stream channel will be made annually to track the effects of the debris accumulations on fish habitat.

The logging operations research includes determining the planning requirements and costs to harvest hardwoods from the riparian openings and the costs to install stream enhancement structures during the logging operation. Time studies will be completed to determine logging operation differences within the 300 and 600 foot openings, adjacent to the 100 foot streamside buffers, and within the upslope harvest area. Time studies will also be completed during stream enhancement activities.

Preliminary Logging Research Results

During the summer of 1993, stands were harvested, conifers were planted in riparian areas, and large woody debris was placed in the stream at two of the study sites. Both study sites are located on Starker Forest properties in the central Oregon Coast Range. One is located on Bark Creek, a tributary to Mary's River, on the east side of the Coast Range near Blodgett, Oregon. The other is located on Buttermilk Creek, a tributary to the Yaquina River, on the west side of the Coast Range near Eddyville, Oregon.

Debris Placement - Bark Creek

The Bark Creek study site was logged from December 1992 to April 1993. The harvest unit was logged using a Madill 071 yarder with a radio controlled mechanical slackpulling carriage. Both 300 foot riparian corridors were logged in a standing skyline configuration with the slackpulling carriage. All the woody debris was placed in Bark Creek during falling or during harvesting with the skyline yarding equipment.

Only two Douglas-fir logs were placed in Bark Creek because the logs could only be placed directly under the skyline and only one skyline road hung over each 300 foot opening. The first log placed was 32 feet long and 20 inches in diameter (560 board feet, Scribner). It took nearly 5 minutes to move it 80 feet from the hillslope into the stream with the skyline system. The second log was 32 feet long and 18 inches in diameter (430 board feet, Scribner). It took 18 minutes to move it 50 feet laterally to the skyline corridor and 160 feet to the stream.

Four alders with root wads attached were placed in Bark Creek. Two were fairly small and were considered non-merchantable. They were bonuses which were toppled into the stream during the regular course of yarding a turn of logs. The other two alders were larger, merchantable trees. It required four attempts to pull the large alders over into the stream. The first attempt resulted in the alder breaking after 8.5 minutes. This alder was not placed in the stream and was subsequently yarded to the landing. The second attempt was more successful. This alder was pulled over until it was in line with the pulling cable at about a 45° angle from vertical. At this point the mechanical advantage was lost so the tree was hand-felled into the stream. This attempt took over 6 minutes. The third attempt took less than 12 minutes and the crew successfully pulled the alder with its root wad intact into the stream. On the fourth and final attempt to pull an alder into the stream, the skyline tailhold stump pulled out, causing the rigging and carriage to fall to the ground. The crew was 7 minutes into this attempt when the tailhold failed. The alder was subsequently hand-felled and yarded to the landing. Six hours were required to repair the carriage, secure a new tailhold stump, and re-rig the cable road. (For a more complete description of the logging engineering aspects of the debris placement at Bark Creek, see the Recommended Reading.)

Debris Placement - Buttermilk Creek

The Buttermilk Creek study site was harvested in March and April 1993. A Madill 071 with a radio controlled slack pulling carriage was used to log this harvest unit. The 300 foot openings were logged in a standing skyline configuration with the slackpulling carriage. However, because of fisheries concerns, stream enhancement activities were permitted only during summer on this stream; therefore, enhancement was completed in August with a hydraulic excavator. Because stream enhancement was not completed during harvesting, the trees to be added to the stream were left standing and were felled when the excavator was there to place them. Thus, this project incurred the additional costs of having a faller available and hauling the excavator to and from the work site.

Of the three potential sites where conifer logs were to be installed in Buttermilk Creek, only two ended up with debris accumulations anchored by conifer debris pieces. Installation at the third site depended on the successful felling of a riparian conifer into the stream. It fell upslope instead and the location of the tree made it impossible to yard the butt log into the stream with the available equipment, without causing undue damage to the streambanks, adjacent buffers, and planted seedlings. The value of the conifer and the time incurred to fell it, approximately 5 minutes, were included as costs for this site.

The other two conifer installations went as planned. A conifer adjacent to the road was felled, bucked into three logs, and partially limbed. The butt log was put into one installation and the second and third cuts were put into a second installation. Travel time to pick up the conifer pieces and walk the excavator to the installation site was approximately 9 minutes at each location and the actual placing of the conifer pieces took approximately 5 minutes at each location.

For the alder installations, we attempted to pull over alders with an excavator. The first alder shattered after about 2 minutes. We made a second attempt on another alder by grabbing the tree lower on the stem. The operator rocked the tree back and forth to loosen the roots. This tree shattered somewhat, but after approximately 7 minutes the operator worked the alder with its root wad into the stream. The alder for the next installation was on the same side of the stream as the excavator and was leaning heavily over the stream. The operator severed some of the roots on the back of the tree and then easily pushed it over into the stream. The second alder took only about 1 minute. Because of the location, the decision was made not to try to push or pull any alders over in the last debris installation. The seven alders intended for incidental debris were all felled in 5 minutes. They were made into a debris jam by the operator in approximately 11 minutes.

Cost Estimates For Debris Placement

The estimated costs for the stream enhancement activities included conservative market values of the materials placed in the stream and the costs incurred while completing the stream enhancement activities during the yarding operations. A summary of the costs are listed in Table 1. The 6 hours of downtime incurred by the contractor when the skyline tailhold failed on Bark Creek are not included in the costs.

Table 1. Timber value and operations costs incurred for stream enhancement activities for the Bark Creek and Buttermilk Creek replications of the Active Riparian Zone Management Project.

Item	Bark Creek		Buttermilk Creek	
Timber value	No.	Value	No.	Value
Douglas-fir logs[a]	2	495.00	6	580.00
Alder logs[b]	3	161.00	15	716.00
Subtotal		656.00		1,296.00
Operations costs				
Skyline yarding equipment and crew		200.00		
Faller				134.00
Hydraulic excavator and operator				590.00
Move in/out				400.00
Subtotal		200.00		1,124.00
Grand total		**$856.00**		**$2,420.00**

[a]Douglas-fir: $500/MBF, stumpage value.
[b]Alder: $310/MBF, stumpage value.

Conclusions

Preliminary logging operations research indicates that stream enhancement can take place during timber harvesting with skyline yarding equipment and be cost effective if well planned and executed. As a cautionary note, care should be exercised when comparing the data from these two case studies. These data only present the costs to get the wood in the stream; no data on the quality of the habitat created by the wood is available yet.

These preliminary data indicate that, for both skyline yarding and hydraulic excavators, the choice of species and quality of the large woody debris installed will determine most of the cost. For example, the first conifer log placement in Bark Creek took only five minutes of yarding crew time, costing approximately $17; however, the market value of the Douglas-fir log was worth, conservatively, $280. This trend also holds for the debris installed in Buttermilk Creek with the hydraulic excavator.

Recommended Reading

Kellogg, L.D., S.J. Pilkerton, and A.E. Skaugset. 1993. Harvesting for active riparian zone management and the effects on multiple forest resources. *In* Environmentally Sensitive Forest Engineering, Proceedings, Council on

Forest Engineering, 16th Annual Meeting, Savannah, Georgia. C.O.F.E., Corvallis, OR.

Arne Skaugset,
Adaptive COPE
Loren Kellogg, Steve Pilkerton, and Mark Miller,
OSU Forest Engineering Department

FUNDAMENTAL COPE

INITIAL ASSESSMENTS OF BIOLOGICAL NITROGEN FIXATION ASSOCIATED WITH LARGE WOODY RESIDUES OF OREGON COASTAL FORESTS

Introduction

Coarse woody residues are conspicuous features of the forest floor in coastal Oregon forests. They are an important component of forest ecosystems, providing habitats for a diversity of plants, animals, and microorganisms. Live plants, such as western hemlock or huckleberry, are partially or completely rooted in coarse woody residues. Selective absorption of nutrients by roots and exudation of energy rich carbon substrates by plants, coupled with lower oxygen tension created by intense microbial activity and respiration, often create in the rhizosphere a selective stimulation of nonsymbiotic nitrogen-fixing organisms that make nitrogen readily available to plants (Figure 1). Plants rooted in woody residues must extract sufficient nutrients for survival and growth. The present study was designed to provide baseline information on the rates of nitrogen fixation by nonsymbiotic bacteria in coarse woody residues before and after tree harvest, and to determine the influence of root activity on rates of nitrogen fixation in coarse woody residues and adjacent mineral soil at three sites in coastal Oregon forests.

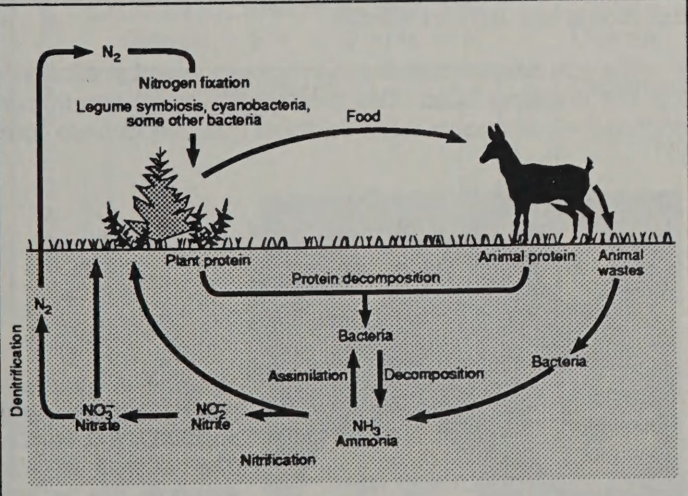

Figure 1. The biological nitrogen cycle. (Adapted from T.D. Brock, K.M. Brock, and D.M. Ward. 1986. Basic Microbiology with Applications. 3rd ed. Prentice-Hall, Englewood Cliffs, New Jersey. 557 p.)

Methods

Coarse woody residues were sampled in three conifer stands and adjacent clearcuts in the Oregon Coast Range. One site is located at 547 m (1794 ft) elevation along the Woods Creek Road on Mary's Peak approximately 24 km (14.9 mi) west of Philomath. This stand consists of large Douglas-fir with varying amounts of western hemlock and several other conifers and broad-leaved species. The second site is located at 183 m (600 ft) elevation in the Cascade Head Experimental Forest near Lincoln City, and is dominated by 60-year-old stands of western hemlock and Sitka spruce. The third site, managed by the Bureau of Land Management, is located at 492 m (1614 ft) elevation approximately 34 km (21 mi) south of Eugene. This site is a 60-year-old stand of mixed Douglas-fir, western hemlock, and western redcedar with varying amounts of understory vegetation.

Coarse woody residues partially colonized by roots were selected at each site in plots located in both forested and adjacent harvested sites. Ten replicate wood samples, five each from root-colonized and noncolonized wood, were removed from woody residues. Nitrogen fixation activity was measured by acetylene reduction method with a gas chromatograph. After the acetylene reduction assay, samples were oven-dried to determine moisture content and dry weight. Similar procedures were used for mineral soil adjacent to each woody residue.

Results and Discussion

Nitrogen fixation activity in woody residues was detected on the BLM and Woods Creek sites, but not on those from the Cascade Head Experimental Forest site. Both forest and clearcut sites on Woods Creek showed higher activity and populations of N_2-fixing microbes in the woody residues and soils than did the other sites. The Cascade Head site contained few N_2-fixing microbes. Root-colonized and noncolonized woody residues had higher activity than the adjacent mineral soil, but the activity between the colonized and noncolonized residues did not appear to differ significantly.

Nitrogen-fixing *Azospirillum* was detected in all woody residues at all three sites, and our study showed this organism was able to utilize wood lignin as an energy source for nitrogenase activity. Most of the N_2-fixing organisms in woody residues were microaerophilic (oxygen sensitive) organisms. The nitrogenase activity in woody residue could be higher if the studies were conducted under low oxygen conditions.

Even though the nitrogen-fixing rates are small compared to those of actinorhizal and leguminous plants, the

nitrogen input of coarse woody debris on a long-term basis may add significantly to the nitrogen budget of forest sites and of clearcut sites where cover of coarse woody residues is sparse.

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USDA Forest Service,
Pacific Northwest Research Station

OF INTEREST

EFFECTS OF FOREST FRAGMENTATION ON SMALL MAMMALS IN SOUTHWEST OREGON

Introduction

Understanding and predicting the consequences of forest fragmentation on wildlife has become a critical issue in the Pacific Northwest. As part of my research into mechanisms and sequence of extinction of wildlife populations surrounded by habitat modification, I explored two sets of questions relevant to Northwest forest management. First, I examined an archipelago of forest remnants in southwestern Oregon at a landscape level, asking how we might, in general, predict which species are most in jeopardy as forest fragmentation proceeds. The second thrust of my field study was to focus on factors affecting the distribution of the California red-backed vole. This enigmatic forest creature eats primarily truffles, the underground fruiting bodies of mycorrhizal fungi. Virtually all trees have an obligate symbiotic relationship with mycorrhizal fungi, and the fungi depend on small mammals such as these voles for dispersal.

Methods

I examined the distribution of small mammals on and around 16 remnants of forest surrounded entirely by stands clearcut within the past 30 years. The remnants ranged in size from 0.3 to 7.2 ha, and were mature to old-growth (i.e., had no history of harvest). I also studied small mammals in five control sites, with control defined as at least 250 ha of relatively continuous and unlogged forest; each remnant was within 13 km (8 mi) of a control site. All sites were in the Klamath Mountains region, within 40 miles of Grants Pass, Oregon.

On both controls and remnants, I placed up to 85 Sherman live traps in a grid with 15-m spacing between traps. Although some remnants were too small to accommodate 85 traps with this spacing, the standardized spacing resulted in the same number of traps per unit area on all remnants. At the same time that I trapped each remnant, 16 traps were set in the clearcut around each remnant. Thus, I assessed species composition of unfragmented forests, forest remnants, and the modified matrix surrounding each remnant.

I also took a closer look at capture dynamics within the forest remnants by testing for "edge effects" on small mammals. Because traps within the grid were uniformly spaced, I could obtain a distance-to-edge measure for all traps by measuring the distance from each trap on the grid perimeter to the nearest remnant edge. My index to how space was used relative to edge distance was the percentage of traps that caught at least one animal during 4 nights of trapping in each 15-m edge class.

Predicting Extinctions on Habitat Remnants

From the air, these forest remnants appear to be islands of old-growth forest in a sea of young stands and clearcuts. This observation has prompted many biologists to use island biogeography theory, and its recent offspring, nested subset analysis, as an approach for analyzing and predicting the rate and sequence of extinctions on habitat remnants. Application of island models assumes, however, that habitat remnants are analogous to oceanic or landbridge islands which are surrounded by a matrix hostile to all island inhabitants; extinctions proceed unless rescued by colonizers from the mainland across the ocean.

These assumptions are often violated in forest remnants, so that island models give conflicting and confusing results. In my study, the standard island biogeographic predictions did not hold; there was no relationship between number of species on a remnant and the size, age, or distance of a remnant from other forest. Furthermore, nested subset analysis gave a confusing result. Although the remnants were nested (meaning that remnants with more species tended to have all of the species present on remnants with fewer species - see Figure 1.), this nested pattern did not result from selective extinction but rather from predictable colonizations. These findings result from the fact that responses to the surrounding matrix are species-specific.

We can see the species-specific responses by considering the trapping data. The four species most commonly captured on remnants differ vastly in their response to both

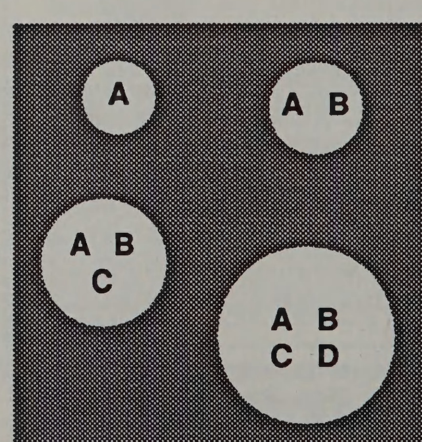

Figure 1. A hypothetical set of stands with 4 species (A,B,C, and D). The stands in the example are nested, because stands with greater numbers of species contain all the species found in less speciose stands.

the surrounding matrix and to the forest/clearcut edge (Figure 2). Deer mice are significantly more likely to be captured as we go from the interior to the edge of remnants, and more likely to be captured in the surrounding matrix than in the remnants. Trowbridge shrews show no difference in capture probability across any edge class or between the remnants and surrounding matrix. Townsend's chipmunks do not show any edge effects, but are significantly less likely to be captured in the matrix than in the remnants. Finally, California red-backed voles show strong negative edge effects and aversion to the surrounding matrix, with a significant decline in capture probability from the forest interior to the edge to the stand edge. Thus, the four most commonly captured species in the remnants show the full range of possible responses to forest fragmentation: strong positive response, strong negative response, no response, and a potential isolation response without any edge effect within the remnant (Figure 2). Clearly, we would be remiss to maintain that these remnants are consistently seen as islands for all species on them.

Some species may violate the island model by colonizing the remnants from the surrounding ocean. For example, the dusky footed woodrat stands out as an especially likely candidate for a species that colonizes remnants from the surrounding matrix. This species was rarely captured in unfragmented controls, but was commonly caught in both the remnants and the surrounding habitat. Although woodrats would be counted in remnant surveys, their presence in the remnants is probably due to their association with the surrounding matrix.

All of this tells us that on forest remnants we cannot reliably predict extinction rates or sequence based on simplistic island models; rather, we must survey space use on remnants relative to both unfragmented controls and the modified matrix surrounding the remnants. The species most threatened by fragmentation are those which are predictably present in continuous forest, but are sometimes missing from remnants because the remnants are surrounded by habitat that has become hostile to immigration and which imposes negative edge effects on the remnants. In this study, the California red-backed vole is such a species. Next, I turn to an examination of factors that affect the distribution of this small mammal.

Rotting Logs, Truffles, and Voles

California red-backed voles on forest remnants exhibit a significant negative edge effect, and are extraordinarily rare in matrix surrounding remnants (I caught only 3 in 1,403 trap nights in the clearcuts). I explored the causes and consequences of vole distribution with David Tallmon and David Clarkson, who were among my field crew and who conducted their undergraduate senior thesis topics on my remnants.

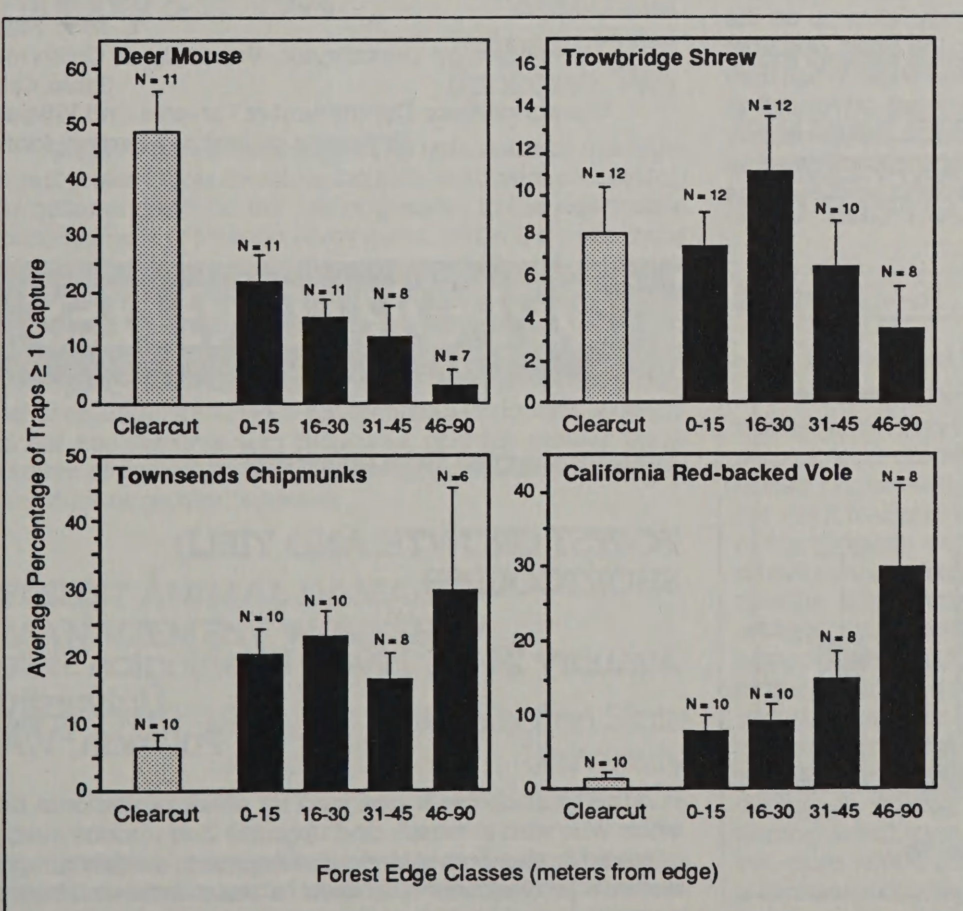

Figure 2. Indices of space use relative to distance from the forest edge for four small mammals in southwest Oregon. The sample sizes above the standard error bars represent the number of remnants in which at least one animal of that species was captured.

Tallmon used radiotelemetry to obtain the first estimates of home range size, and to determine the relationship between red-backed voles and coarse woody debris. Although logs covered an average of only 7 percent of vole home ranges, 98 percent of all vole telemetry locations were underneath logs. Furthermore, voles used logs in later stages of decay significantly more often than less decayed logs.

The strong concordance between voles and logs, by itself, argues strongly for the maintenance of decayed logs to ensure suitable vole habitat. The case is made even stronger, however, by Clarkson's study, which explored factors affecting the distribution of the vole's primary food item, mycorrhizal fungi sporocarps (truffles) on and around four of my remnants. The first and most important finding from this work was that truffles were exceptionally rare in areas surrounding these remnant forest stands. Mycorrhizal fungi depend on tree roots for energy (photosynthetic product), so that clearcutting trees would be expected to result in the loss of mycorrhizal fungi and their fruiting bodies. Secondly, we found that truffles on remnants were most

likely to be found underneath logs. Finally, we compared truffle distribution plots to the distribution of red-backed vole captures, and found that red-backed voles were much more likely to be captured in areas where truffles were identified.

So, in our study area, we established that both voles and their major food item were virtually absent from regenerating stands less than 30 years old surrounding unharvested remnants. Because voles are both the primary dispersal vectors for mycorrhizal fungi and dependent on the sporocarps for food, this response likely feeds back on itself. We further believe that logs (coarse woody debris) play a key role in mitigating these mutually negative effects in clearcuts, because the distribution of both voles and truffles hinge, in part, on the presence of logs.

The question arises, then, whether the negative edge effect exhibited by red-backed voles arises from the distribution of logs in remnants. I used line transect sampling to assay log distribution in different edge classes on all forest remnants, and found that both the volume and number of logs increases from the interior to the edge of remnants (Figure 3). Such a result may seem surprising, as it is opposite from what we would expect if increased logs means increased voles. However, closer consideration reveals that the log numbers and volume in the interior edge classes are mostly within the range of values obtained previously for Oregon Coast Range forest stands older than 80 years, while the first two edge classes contain up to 1.5 times more. This points toward an accumulation of woody biomass on the remnant edge from cut trees falling into the forest, and from death and blowdown of trees on the forest edge. When they fall, these trees become logs which are not advanced in decay; thus, they apparently represent excess coarse woody debris which falls into remnants from logging activities but which does not necessarily benefit log-using wildlife in the short term.

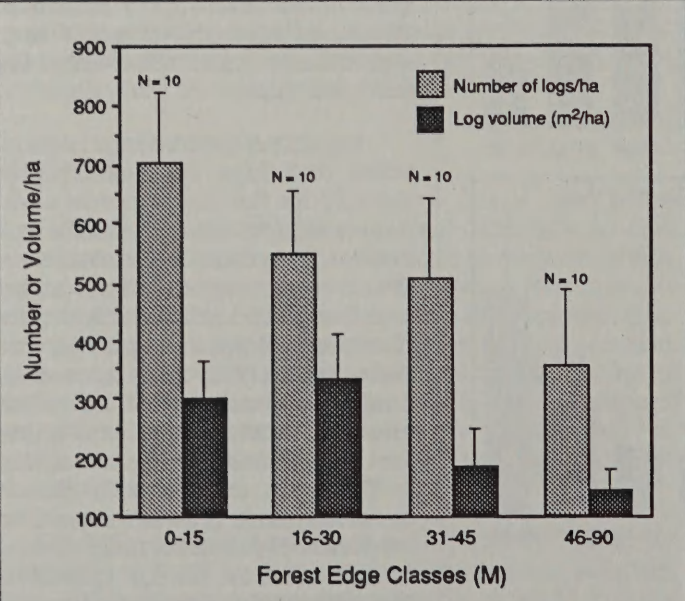

Figure 3. Mean and standard errors of downed log biomass values for all forest remnants in southwest Oregon. For each edge class (distance from the stand edge), N represents the number of remnants for both indices.

Conclusions

Responses to forest fragmentation varies dramatically among species of small mammals, implying that simplistic island models are inappropriate, and that the likelihood of local extinction can only be determined by examination of the remnants, the surrounding matrix, and controls. One species which can become effectively isolated by clearcutting, the California red-backed vole, is strongly linked to coarse woody debris in an advanced state of decay. Mycorrhizal fungi, which voles eat and which improve tree survival and growth, are also missing from clearcuts but might be increased in abundance by the moisture reservoirs found in decaying logs. Thus, forest management activities that seek to maintain mycorrhizal associations by leaving trees and coarse woody debris should benefit not only tree regeneration but also wildlife species which depend on and are critical to mycorrhizal fungi. Although the issue does not lend itself to simple analysis or solutions, avenues for positive change in forest management are becoming increasingly clear.

In closing, I would like to acknowledge the assistance of my extraordinary field crew, as well as managers and biologists from State and Federal agencies in southwest Oregon. This study was funded by grants from the Pacific Northwest Research Station and the National Audubon Society.

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OPPORTUNITIES

From Washington State University:

FOREST GROWTH AND YIELD SHORTCOURSE

January 24-28, 1994 Washington State University Pullman, WA

This short course is designed for either professional foresters who wish to refresh and upgrade their understanding of the basic elements of stand development, or other natural resource professionals who need a basic understanding of stand development. Lectures are interspersed with class exercises that provide students an opportunity to gain hands-on experience using the concepts and techniques presented in the lectures.

HUMAN DIMENSIONS IN ECOSYSTEM MANAGEMENT

February 1-4, 1994 — Washington State University, Pullman, WA

An intensive course designed to enable natural resource professionals to better understand and facilitate field application of the human dimensions of ecosystem management. Topics may include: evolution of ecosystem management as a social/political phenomenon; legal framework for ecosystem management; social impacts of converting to ecosystem management; institutional barriers to ecosystem management; role of collaboration in achieving ecosystem management; relationship between ecosystem management and culture, including Native American concerns; and social assessment. A survey of attendees will be conducted in advance to determine the level of interest in the topics listed.

GENE 94: GENETICS EDUCATION FOR NORTHWEST ECOSYSTEMS

February 6-11, 1994 — WestCoast Ridpath Hotel, Spokane, WA

GENE 94 is a course designed for both resource management professionals and tree improvement workers seeking to better understand the role of genetics in the sustainable management of forested ecosystems. While the main focus of the course is on forest tree species, it also considers associated plants and animals as integral components of ecosystem biodiversity that can be protected or enhanced by proper gene resource management. The course covers principles, concepts, methods, and approaches fundamental to an understanding of the technical intricacies of operational tree improvement programs, and the genetic implications of current and alternative silvicultural regimes and forest management systems.

FOREST ANIMAL DAMAGE MANAGEMENT WORKSHOP

May 17-19, 1994 — Washington State University, Pullman, WA

This hands-on course is geared towards natural resource professionals who need to understand more about forest use by wildlife, types of forest damage caused by wildlife, and methods used to control damage. Audio-visual aids, handouts, demonstration materials, field tours, and exercises will be used to supplement the course.

RESTORING OR REHABILITATING DAMAGED ECOSYSTEMS

June 7-9, 1994 — WestCoast Ridpath Hotel, Spokane, WA

This workshop will provide an introduction to principles of land reclamation and their application to drastically disturbed forest and rangeland ecosystems. Although the reclamation of mined land will be the conceptual focus and framework for the workshop, principles and practices will also apply directly or indirectly to other types of disturbances as well. The workshop is targeted to natural resource management professionals in agencies and industry who have little or no background in reclamation. It will provide classroom instruction, discussions and exercises, and field exposure to the application of reclamation technology. Topics will include foundational ecological concepts and principles, reclamation planning, plant materials, reclamation methods, and post-reclamation management.

For more information on the above conferences, contact: Conferences and Institutes, Washington State University, 208 Van Doren Hall, Pullman, WA 99164-5222, or call (509) 335-3530 or (800) 942-4978).

From Oregon State University:

THE ECOLOGY AND MANAGEMENT OF OREGON COAST RANGE FORESTS: A MID-TERM COPE SYMPOSIUM

March 29-31, 1994 — Salishan Lodge, Gleneden Beach, OR

This symposium will highlight COPE research and our current understanding of the ecology and management of riparian and upland sites in the Oregon Coast Range. Presented papers will draw primarily on research funded by the Adaptive and Fundamental COPE programs. Day one of the program will emphasize riparian zone ecology and management, featuring presentations and discussions of riparian plant communities, wildlife associations, aquatic ecology, fish communities, and riparian silviculture. A poster session addressing a broad scope of forestry-related issues in the Coast Range will follow in the evening. Day two will include discussion of a diverse collection of topics, with presentations on stream ecosystem restoration, upslope vegetative communities, upslope silviculture, wildlife associations in upland landscapes, landscape approaches to management, and social science considerations. The day will close with a discussion by a panel of individuals with a diverse set of perspectives on management of Coast Range forests. On the third day, there will be an optional field trip that will provide a first-hand look at many of the areas and topics discussed in the symposium. The number of seats available for the field trip will be limited.

For more information on the above conferences, contact: College of Forestry Conference Office, Oregon State University, Peavy Hall 202, Corvallis, OR 97331-5707, or Telephone (503) 737-2329, or FAX (503) 737-2668.

PUBLICATION REVIEWS

DENSITY MANAGEMENT GUIDE FOR RED ALDER by K.J. Puettmann, D.S. DeBell, and D.E. Hibbs. 1993. Forest Research Laboratory, Oregon State University, Corvallis. Research Contribution 2. 6 p. In response to an expected shortage of red alder for lumber in the future, work was done to create a density diagram for management of alder. The diagram is presented as a general guide to determine the planting density required to reach a desired stem diameter or stand yield at the end of the rotation. The diagram does not, however, include factors affecting tree growth that are not density-related.

DB

INTERSPECIFIC COMPETITION AND OTHER FACTORS INFLUENCING THE PERFORMANCE OF DOUGLAS-FIR SAPLINGS IN THE OREGON COAST RANGE by R.G. Wagner and S.R. Radosevich. 1991. Canadian Journal of Forest Research 21:829-835. In this study, multiple linear regression analysis was used to develop models that integrated factors affecting Douglas-fir growth and survival. Data collected from two long-term studies examining reforestation practices were used. Results from individual-tree models supported previous research demonstrating that competing vegetation and animal damage are negatively correlated with tree size. Initial tree size, tree age, and use of prescribed burning were positively correlated with tree size. Saplings were larger on steep, southeast slopes. Integrated models combine these factors into one set of equations, which can be used to better determine silvicultural and nursery practices and provide a basis for growth models of young plantations. These models indicated that tree age, competing vegetation, animal damage, and initial seedling size were dominant influences on growth. In contrast, prescribed burning and topography were positively correlated with tree size, but only had a minor influence on growth.

KGM

SMALL MAMMAL AND AMPHIBIAN COMMUNITIES AND HABITAT ASSOCIATIONS IN RED ALDER STANDS, CENTRAL OREGON COAST RANGE by W.C. McComb, C.L. Chambers, and M. Newton. 1993. Northwest Science 67(3):181-188. In this study, McComb et al. examine small mammal and amphibian population abundance in red alder riparian habitat and associated red alder upslope habitats. Sample sizes of animals trapped were adequate to compare abundances of streamside and upslope populations of two species of salamanders (Ensatina salamanders and roughskin newts) and four species of mammals (Trowbridge's shrews, Pacific shrews, deer mice, and Virginia opossums). Of these species, only Ensatina salamanders were more abundant in upslope habitats than in riparian zones. The other species exhibited no statistically significant differences between areas. The similarity of small mammal and amphibian populations in upslope and riparian areas was attributed to the overall similarity of the structure and composition of the vegetative community in the two areas. The paper concludes with a discussion of the management implications of the findings, which include retaining coarse woody debris for wildlife populations and maintaining vegetative diversity in alder stands.

JPH

MECHANIZED FELLING IN THE PACIFIC NORTHWEST: EXISTING AND FUTURE TECHNOLOGY by L.D. Kellogg and M. Brink. 1992. Forest Research Laboratory, Oregon State University, Corvallis. Special Publication 25. 7 p.

TERMINOLOGY OF GROUND-BASED MECHANIZED LOGGING IN THE PACIFIC NORTHWEST by L.D. Kellogg, P. Bettinger, and D. Studier. 1993. Forest Research Laboratory, Oregon State University, Corvallis. Research Contribution 1. 12 p.

CARRIAGES FOR SKYLINES by D. Studier. 1993. Forest Research Laboratory, Oregon State University, Corvallis. Research Contribution 3. 14 p.

KEY ISSUES AND FUTURE DIRECTIONS OF MECHANIZED HARVESTING: DISCUSSION AND GUIDANCE FROM WORKING GROUPS by P. Bettinger, L.D. Kellogg, and E.D. Olsen. 1993. Forest Research Laboratory, Oregon State University, Corvallis. Research Contribution 5. 8 p.

Forest management in the Pacific Northwest is currently in a state of transition. One major change causing this transition is a shift from logging larger, old-growth trees to shorter-rotation, small-diameter trees. Another change is the growing trend toward forestry practices on public lands that encompass "ecosystem management" principles. The net result of these changes is increased harvesting and commercial thinning of young stands with more residual trees left standing. Timber harvesting equipment and processes are changing to accommodate these changes in both timber size and forest policy. One very visible change is the increasing move to mechanized harvesting in the Pacific Northwest. Over the past several months, the Forest Research Laboratory at Oregon State University has released a series of publications that will be helpful to those who want to learn about contemporary timber harvesting technologies or to those who simply want to stay abreast of the changes in this technology.

AES

The above publications are available from: Forestry Publications Office, Oregon State University, Forest Research Laboratory 227, Corvallis, OR 97331-7401.

EFFECTIVENESS OF SELECTED STREAM IMPROVEMENT TECHNIQUES TO CREATE SUITABLE SUMMER AND WINTER REARING HABITAT FOR JUVENILE COHO SALMON (*ONCORHYNCHUS KISUTCH*) IN OREGON COASTAL STREAMS by T.E. Nickelson, M.F. Solazzi, S.L. Johnson, and J.D. Rodgers. 1992. Canadian Journal of Fisheries and Aquatic Sciences 49:790-794. Both naturally occurring and constructed dammed pools, plunge pools, and alcoves were sampled for juvenile coho salmon during both the summer and winter to compare the effectiveness of these different constructed habitat types and to compare the density of juvenile coho salmon in constructed habitats with natural habitats of the same type. There was no difference in coho density among constructed pools during the summer, and the mean density for juvenile coho during summer was similar for constructed and natural pool habitats. While it was not statistically significant, the data strongly suggested that constructed alcoves support greater densities of juvenile coho during winter than either constructed dammed or plunge pools. The winter density of juvenile coho was similar for constructed versus natural habitats for alcoves and plunge pools, but it was significantly less for constructed versus natural dammed pools. The addition of brush bundles to the constructed dammed and plunge pools increased the winter density of juvenile coho salmon in the dammed pools, but not in the plunge pools. The authors suggest that in a system that is fully seeded, winter habitat will limit the production of coho salmon in coastal Oregon streams. Also, the development of off-channel or alcove habitat has the greatest potential to increase production of wild coho smolts in Oregon coastal streams.

AES

VEGETATIONAL AND CLIMATIC HISTORY OF THE PACIFIC NORTHWEST DURING THE LAST 20,000 YEARS: IMPLICATIONS FOR UNDERSTANDING PRESENT-DAY BIODIVERSITY by C. Whitlock. 1992. Northwest Environmental Journal 8:5-28. Using paleobotanical data from the Pacific Northwest from the last 20,000 years, Whitlock describes the changes in climate and vegetation resulting from the advance and retreat of glacial ice sheets. Implications of a 4-5° warming, predicted as possibly occurring in the next century, are evaluated from a paleocological perspective. Whitlock suggests that an emphasis on preservation of areas with high species richness fails to recognize the ephemeral nature of associations resulting from large-scale climatic changes. The long-term preservation of biological communities or vegetation types will probably be unsuccessful because climate change is likely to dismantle the vegetation or community type relatively quickly. These areas of high species richness are likely to serve as a source for taxa that will comprise future communities, but will not be the final location of the community. Instead, heterogeneous environments should be identified and preserved to allow species to adjust their local ranges as the climate changes. In the Pacific Northwest this would include reserves ranging over temperature and precipitation gradients within the region. This approach would allow species to shift as the climate changed. Unusual habitats that are restricted by edaphic conditions also should be preserved since they appear to respond to climate changes on shorter scales (less than 500 years) than do wider ranging communities (less than 1,000 years).

KGM

AN APPROACH FOR MANAGING VERTEBRATE DIVERSITY ACROSS MULTIPLE-USE LANDSCAPES by A.J. Hansen, S.L. Garman, B. Marks, and D.L. Urban. 1993. Ecological Applications 3(3:481-496. This paper presents work supported by the COPE program describing an approach to managing multiple-use landscapes for animal biodiversity. The approach involves five steps: (1) establishment of a clear set of objectives; (2) association of target species with specific habitat configurations; (3) assessment of potential sensitivity of species through examination of habitat suitability and the life-history characteristics of species; (4) evaluation of alternative management prescriptions through simulation models; and (5) implementation of the preferred alternative and monitoring the results. The authors demonstrate application of their approach on a 3300 ha section of the Cook-Quentin watershed in the Willamette National Forest on the west side of the Oregon Cascades. The paper focuses on birds, tracking the probable responses of 51 species to four management prescriptions. Hansen and his coauthors analyzed the likely impacts of each of these prescriptions on timber production and biodiversity. In their conclusion, they discuss the limitations of this approach. However, they emphasize that, despite its shortcomings, it would enhance our ability to objectively evaluate the impacts of different management prescriptions on a diverse set of resources.

JPH

COPE

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COPE Report

Coastal Oregon Productivity Enhancement Program

Volume 7, Number 2 & 3 July 1994

SPECIAL SYMPOSIUM ISSUE

The Ecology & Management of Oregon Coast Range Forests

From the Program Manager

Over the last 17 years I have managed to attend a number of workshops and symposia. Some didn't turn out very well, although the vast majority did meet my expectations. Every now and then, however, one comes along that really generates some energy. The focus of this special issue of the COPE Report was such an event. Let me tell you why.

My impression was formed mostly from watching the participants and their reactions to the information presented. There was an intensity and enthusiasm I haven't seen for awhile. In part, this was due to the seriousness and complexity of the issues we face in the Oregon Coast Range and the pressing need for new information. Undoubtedly, however, much of the energy resulted from the information presented. Some old beliefs were reinforced while others were called into question. More importantly, research results with practical, management-oriented implications were discussed. They ranged from how to get conifers regenerated in riparian areas to the placement of large woody debris in streams to improve fish habitat. These are just several examples of many instances in which the sense of excitement about the new information being developed was fueled. Certainly John Hayes and his colleagues on the Adaptive COPE Team, as well as the speakers and those who contributed posters, are to be congratulated for providing us with this symposium.

As you read this issue of the COPE Report, keep in mind that the content represents only a selected sample of the information discussed during the symposium and only a portion of all COPE-sponsored research. Twenty studies have already been completed while 38 are currently underway. Needless to say, there is still a lot of new information yet to come during the next 4 years.

Steve Hobbs

COPE Report

This issue of the COPE Report was prepared by Gretchen Bracher, William H. Emmingham, Skye Etessami, John Hayes, Kathleen Maas, and Judy Starnes. The COPE Report is produced quarterly as a contribution of Adaptive COPE. Because of space limitations, articles appear as extended abstracts. Results and conclusions may be based on preliminary data or analysis. Readers interested in learning more about a study should contact the principal investigator or wait for formal publication of more complete results. Comments and suggestions concerning the content of the COPE Report are welcomed and encouraged. To receive this free newsletter, or for information about Adaptive COPE, contact Adaptive COPE, 2030 S. Marine Science Dr., Newport, OR 97365, (503) 867-0220. For specifics on the overall COPE Program, contact Steve Hobbs, COPE Program Manager, Forestry Sciences Laboratory, 3200 SW Jefferson Way, Corvallis, OR 97331, (503) 750-7426.

The COPE Program is a cooperative effort between Oregon State University's College of Forestry, the USDA Forest Service, Pacific Northwest Research Station, the USDI Bureau of Land Management, other federal and state agencies, forest industry, county governments, and the Oregon Small Woodland Association. The intent of the program is to provide resource managers and the public with information relative to the issues and opportunities associated with the management of fish, timber, water, wildlife, and other resources of the Oregon Coast Range. The COPE Program emphasizes an integrated approach—an integration of research and education and an integration of scientific disciplines—to find effective ways to manage these diverse resources collectively.

The COPE Program has two related components: Fundamental COPE and Adaptive COPE. Comprised of OSU and PNW scientists based primarily in Corvallis, Fundamental COPE addresses problems related to riparian zone management and reforestation in the Coast Range through basic research. Adaptive COPE is comprised of an interdisciplinary team responsible for applying and adapting new and existing research information to solve specific management problems. Stationed on the coast in Newport at the Hatfield Marine Science Center, the Adaptive COPE team is also responsible for providing continuing education opportunities to facilitate technology transfer.

SYMPOSIUM OVERVIEW

On March 29 and 30, 1994, the Adaptive COPE team hosted a symposium entitled "The Ecology and Management of Oregon Coast Range Forests." The symposium was followed by a field tour on March 31. At just past the mid-point of the COPE Program, the symposium was designed to encapsulate the diversity of research accomplishments achieved thus far by the COPE Program, to identify areas needed for further research, and to provide a forum where managers, practitioners, researchers, and concerned individuals could discuss areas of common interest. Oral presentations were given by 20 researchers, 21 posters were presented, and an hour-long video presentation was made. A closing discussion led by four panelists addressed future directions for the management of Oregon Coast Range forests. The symposium covered a wide range of topics, including the ecology and management of broad-leafed trees and shrubs, stream restoration, wildlife populations in riparian and upslope ecosystems, silvicultural approaches, fish population responses to habitat changes, susceptibility of conifers to *Phellinus* infection, and the role of recreation in the region's shifting economy. The field tour included visits to five sites and presentations by 13 researchers. Approximately 250 people attended the symposium which was held at Salishan Lodge on the Oregon Coast, and about 70 participated in the field tour.

This special issue of the COPE Report highlights some of the presentations from the symposium. Because of the breadth of subject matter and depth of many of the presentations, it would be impossible to summarize the entire conference adequately in a single newsletter. Instead, we have provided a sampling of presentations, touching on a small portion of the variety presented in the program. A limited number of booklets with abstracts from the presentations are available by request from Adaptive COPE, in Newport.

KEYNOTE ADDRESS

THE ECOLOGY AND MANAGEMENT OF COAST RANGE FORESTS

MARCH 28, 1994, GLENEDEN BEACH, OR

It is a great pleasure for me to be a participant in this COPE symposium that celebrates the mid-point in the COPE Program. I participated in the early stages of COPE, helping to get it organized and running, and I can't begin to tell you how pleased I am to see how well it has succeeded and how much has been accomplished. It was almost exactly 10 years ago that the foundation for COPE was laid with our congressional delegation, so this is a very special celebration.

My role as keynote speaker today is to begin this symposium by providing an historical perspective of COPE's origins, of the value of programs like this, and then speculate a bit about the future.

Let me begin at the beginning. Why did COPE start in the first place? The answer is very simple. COPE began in response to a local need, one forcefully expressed by resource managers in industry and government. These managers could foresee the growing importance of coastal forests and, at the same time, the increasing conflicts over resource use and allocation. Mind you, this was in the early 1980's, before the spotted owl, marbled murrelet, or salmon issues became household words. Even so, these managers appreciated both the richness of these forest resources and the complexities of management for multiple values. They also appreciated the need for new information to help them make good decisions.

And the managers didn't stop here. They were willing to make a financial commitment to help get some answers. So were local policy makers, for, like the managers, they clearly understood the relationship between natural resource management and the economic and social health of their communities. This partnership between local resource managers and local government, both willing to invest their resources in finding answers, made a very big impression on the congressional delegation. Here was an example of people coming together to meet an important need.

Senator Hatfield and Congressman AuCoin, both key figures in the federal appropriation process, stepped forward and provided the congressional leadership to secure the federal assistance that supports the fundamental COPE research. Their case was clearly strengthened by the local commitment and vision.

How did we decide what to work on? From the nearly infinite array of resource management problems, how did we select riparian management and reforestation? It was fairly simple—we asked. We put in place an advisory council that represents cooperators and a broad spectrum of resource management interests and organizations. We then held a series of workshops with local people at three locations on the coast—Astoria, Newport, and Coos Bay-North Bend. Each workshop produced a prioritized laundry list of needs for information. They were amazingly similar. Some of the needs were for information already available and this became the basis for the extension and technology transfer program. Some of the needs expressed were for help with problems beyond the scope of what we could do, like high-speed highways from I-5 to the coast or destination resorts.

But most of the needs were clearly for critical resource management issues that needed new information. We asked our advisory council to help us decide which issues we should focus on and they selected two—riparian manage-

ment and reforestation. They couldn't have picked two better ones. Later, the reforestation issue was broadened a bit to "upslope ecology and management," but it clearly fit the original charge. Once the management issues were defined, the scientists then were able to hone in on the scientific questions to be answered and they structured the research program accordingly.

The structure of COPE, with its local adaptive team and the fundamental research team, is a structure we used successfully in southwest Oregon on a reforestation research and technology transfer program called the Forestry Intensified Research program, or FIR. The key to the success of the FIR Program was the same kind of local support and commitment we have in COPE coupled with an "adaptive research and education" team that was built in from the beginning of the program and served the local managers and policy-makers. In FIR, the adaptive team, was clearly the secret to our success and we expect that to be the case in COPE. They are an essential channel of communication from the scientists to the managers and vice-versa.

My very biased view is that programs like COPE have an unusually important role to play in the decision-making process about natural resource use and management. Let me provide several reasons.

First, it is a highly focused effort on a complex topic. We've worked on complex management issues before, but always in a piecemeal, poorly funded manner. In COPE, we have over 80 scientists concentrating on a limited number of coastal forest resource issues.

Similarly, we have been able to assemble a critical mass of scientific and management expertise to deal with the need. Thanks to our cooperators and congressional delegation, we also have the financial resources to tackle the problems. By the time COPE ends, we will have put $20 million into the research and technology transfer. That is a lot of money, but a pittance compared to the values at stake.

A key reason that COPE is important in decision making is that we have a broad range of disciplines working in a coordinated way on the problems. I believe that provides more comprehensive answers to these complex problems. I also believe that decision makers find the answers more believable. They have more confidence in the results generated from interdisciplinary work.

Another important reason for COPE's believability is that decision-makers from agencies, industry, and local government are involved at every stage and participate not only in the identification of the problems, but help us collect information and review the findings in an on-going process of participation.

Symposiums like this one are a fourth reason for the value of COPE. We ask managers to come share their expertise and experience with others. It is not just a program of sharing research results, but important knowledge gleaned from the collective experience of people working in the forest and solving problems.

When COPE ends, we hope that a final product will be a major book and a symposium that synthesize all we've learned. We did that with FIR and the product was an outstanding "manual" that will guide reforestation of harsh sites, not just in southwestern Oregon, for decades. It is this synthesis of knowledge that will ultimately be the greatest help to decision makers and policy makers. Individual study results, scientific journal papers, and *COPE Report* articles are all helpful, but it is the synthesis that is ultimately more useful.

Finally, one of the lasting legacies of a program like COPE is the demonstrations that are installed. They are helpful both in the short run to help people see on the ground what is happening as we conduct the research, but also as longer term benchmarks that can be revisited following the termination of the intensive research to pick up long-term trends. Often, people learn more effectively by seeing things on the ground rather than reading an article or hearing a speech. Demonstrations help meet that need.

I expect COPE to have a great deal of scientific and political significance once the program is completed. Indeed, it has already contributed information that has been used in the structure of new riparian management rules for the Oregon Forest Practices Act. Any scientific work can do that, but I believe that programs like COPE have a greater chance of making a difference than individual research studies.

Results from interdisciplinary research carry more credibility, in my view. So does research that represents a strong commitment by a group of cooperators working on a common set of problems. Synthesizing results in a fashion that is understandable helps interpret for policy-makers what is important and how it all fits together.

Where do we go from here, now that we are half-way through the program? In my view, several key tasks remain. The first, most obvious one, is to complete the studies now underway. The second, is to continue to incorporate the input and experience of resource managers into the work we do. Are the preliminary findings helpful? Do they match your view of reality? What adjustments do we need to make in the last years of the studies to make them more useful?

We need to continue to work hard together on transferring the new information we develop to those who can best use it. If we can get the resources together, we really need to help the public better understand what we have learned in COPE and what it means. We've made some proposals to outside granting agencies to help us do that.

Finally, we need to complete the synthesis book as a final wrap-up of COPE. We have taken some steps to make that happen financially with our cooperators so that we build in the synthesis work and don't do it as an afterthought following termination of the funding. In large measure, that's what happened with FIR and though successful, it was neither easy or fun!

Let me close by saying thank you to all who have made COPE a reality by their support and to all those who have

made it successful by their hard work. It has truly been an outstanding example of cooperation and commitment by a great many organizations and people. Industry cooperators have continued to participate during some very difficult financial times. So have counties. State and federal agencies have continued to participate even in these bleak days of budget reductions. And our congressional support, especially in Senator Hatfield, has remained committed throughout.

When we complete COPE, I believe we will have made a huge increase in our knowledge base about the function and management of coastal forest resources. I expect that we will have new ways of looking at these forests and, in turn, some new approaches to management will be forthcoming. If FIR is any indication, we expect to see some long-term professional "bonding" that will occur as resource professionals from different organizations and different disciplines work and learn together.

Again, my thanks and congratulations to all who have made COPE possible and successful thus far. Thanks to all of you for participating in this mid-program review symposium. I look forward to the next two days.

George W. Brown, Dean
College of Forestry, OSU

SELECTED PRESENTATIONS

HABITAT RELATIONSHIPS AND RIPARIAN ZONE ASSOCIATIONS OF BATS IN MANAGED FORESTS IN THE OREGON COAST RANGE: A NEW ADAPTIVE COPE STUDY.

Introduction

Understanding the costs and benefits of management strategies is essential to informed management of forest ecosystems in the Oregon Coast Range. Studies of several species of vertebrates are beginning to clarify the relationships between wildlife and habitat structure and are enabling the influence of management programs on wildlife populations to be evaluated. One important wildlife group that has been neglected in these studies is the bats.

Bats are extremely important to the region's biodiversity and ecology. Nearly 20 percent of the mammal species occurring in the Oregon Coast Range are bats. Of the 11 species of bats occurring in the Coast Range and Siskiyous (Table 1), three are listed as sensitive species by the Oregon Department of Fish and Wildlife, and one of these is a candidate for federal threatened or endangered status. Bats are significant predators of nocturnal insects, some of which are forest pests. In addition, bats are prey to some species of mammals and raptors.

Table 1. Bats of the Oregon Coast Range and Siskiyou Mountains

Pallid Bat[1,2]	*Antrozous pallidus*
Big Brown Bat	*Eptesicus fuscus*
California Myotis	*Myotis californicus*
Long-eared Myotis	*Myotis evotis*
Little Brown Myotis	*Myotis lucifugus*
Fringed Myotis[2]	*Myotis thysanodes*
Long-legged Myotis	*Myotis volans*
Yuma Myotis	*Myotis yumanensis*
Silver-haired Bat	*Lasionycteris noctivagans*
Hoary Bat	*Lasiurus cinereus*
Townsend's Big-eared Bat[2,3]	*Plecotus townsendii*

[1] Found in the Siskiyous only.
[2] On the ODFW Sensitive Species list.
[3] A candidate species for listing by the federal government.

The single study to date that examined bat communities in the Oregon Coast Range showed that the abundance and diversity of bats respond dramatically to variation in forest structure in upland habitat; upland habitat appears to be used primarily for roosting by many species of bats (see Recommended Readings). Riparian zones are used by bats for both roosting and foraging. Although there is some evidence suggesting bat populations may be influenced by habitat structure in riparian zones, no studies have critically examined this relationship. In light of the importance of bats to forest ecology and regional biodiversity, the sensitive status of some species of bats, the possible influences land management practices have on viability of bat populations, and the paucity of information on riparian habitat associations of bats, we have undertaken a research program to investigate bat habitat associations in riparian zones and adjacent upland stands.

Methodological Approach

All species of bats occurring in the Oregon Coast Range use echolocation to navigate and to detect insect prey. Bats emit a series of high frequency pulses (frequencies generally higher than those audible to an unaided human ear) that bounce off objects in the environment. By monitoring the characteristics of the echoes returning to them, bats are able to collect and interpret information about their surroundings.

Recent technological advances have resulted in the development of relatively low-cost electronic equipment enabling the detection, recording, and interpretation of echolocation signals emitted by bats. We are using this ultrasonic detection equipment, known as "bat detectors," in conjunction with mist netting to monitor bat activity along riparian zones. Our study has two major objectives. One is

to identify bat species using riparian zones in Coast Range forests. The second is to determine the influences of landscape structure, stand structure, and stream and riparian characteristics on patterns of habitat utilization by bats.

Preliminary Results

Because of a lack of data on the natural history and activity patterns of bats in the Oregon Coast Range, we needed to gather some basic information before addressing significant management questions. We began a series of preliminary studies during the summer and fall of 1993 to answer two basic questions: what are the echolocation signatures of different species of bats in the Oregon Coast Range, and how much temporal variation in activity occurs along riparian zones?

To identify specific echolocation signatures of different species of bats, we mist- netted bats and recorded their calls upon release. Using time frequency curves (Figure 1), we are building a catalogue of bat calls. We will later use this catalogue to identify species on the basis of the shape, duration, maximum frequency and minimum frequency of echolocation calls plotted on time frequency curves. For example, our preliminary work suggests that the echolocation pulse of *Myotis yumanensis* in the central Oregon Coast Range is relatively steep with an inflection point, lasts 3 to 7 milliseconds, has a maximum frequency around 100 KHz and a minimum frequency between 40 and 47 KHz (Figure 1A). In contrast, the echolocation pulse of *Myotis evotis* has no inflection point, is shorter in duration, lasting only 1 to 3 milliseconds, and is lower in frequency, with minimum frequencies between 30 and 35 KHz (Figure 1B). Although we may not be able to determine differences in echolocation patterns between all species of bats (especially among some of the species in the genus *Myotis*), we are confident that we will be able to identify all calls to the genus level and many to the species level. This information will be essential in determination of species-specific responses to riparian zone structure and management activities.

Understanding temporal patterns of variation in bat activity is critical to the design of our study. Factors that substantially effect levels of bat activity other than habitat structure or management activities need to be identified so that their influences can be minimized in the experimental design. During 30 nights from July through September, 1993, we monitored bat activity at two streams, Bark Creek and Buttermilk Creek. There were considerable differences in the amount of activity between the two sites, with Bark Creek generally having about five times as much activity as Buttermilk Creek. There was also substantial temporal variation in activity during this time, with activity varying over ten-fold at each stream (Figure 2). However, the temporal variation was not random and a "good night" for bats at one location was generally also a "good night" at the other. This temporal pattern of variation appears to be closely associated with minimum nightly temperatures. As a result of these findings, we will structure our activity-monitoring program so that comparisons are paired by night, thereby minimizing extraneous variation due to weather conditions.

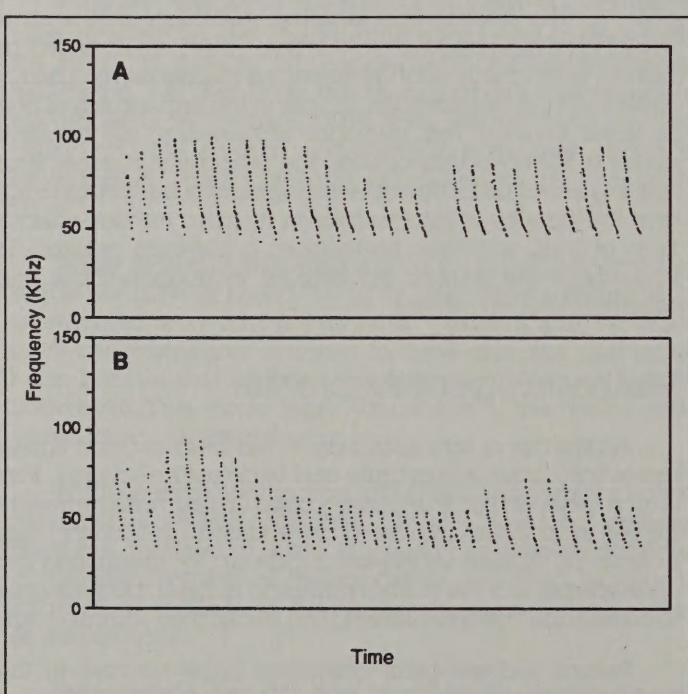

Figure 1. Time-frequency curves of echolocation calls for an individual Myotis yumanensis (A) and Myotis evotis (B) captured and released in August, 1993. The time between echolocation calls was condensed to allow several calls to be displayed on a single graph. Actual times between echolocation pulses is considerably longer.

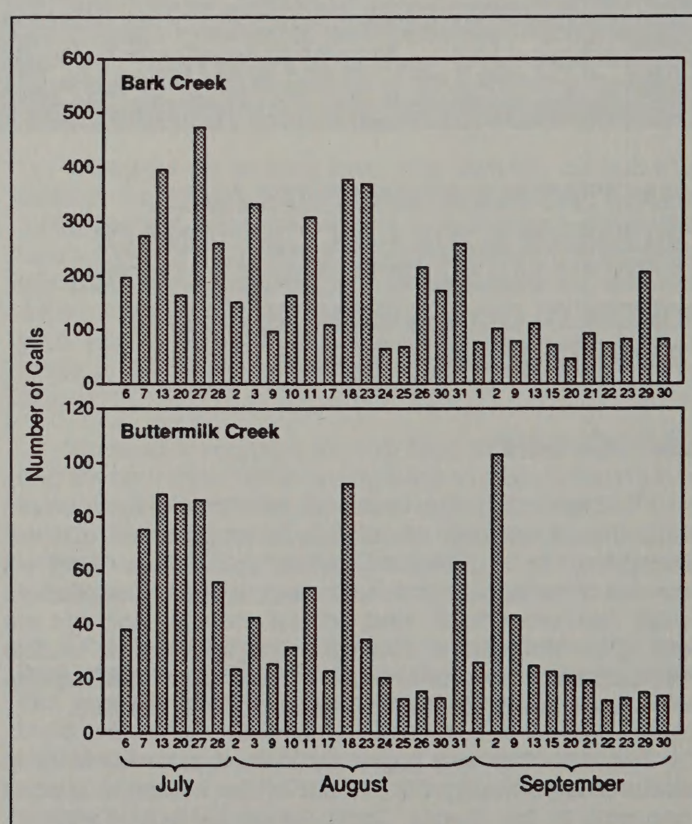

Figure 2. Variation in bat activity at Bark Creek and Buttermilk Creek during July, August, and September 1993. Axes for the two creeks are scaled differently.

Studies for 1994 and Beyond

During the upcoming field season, we plan to complete our analyses of species-specific echolocation signatures and patterns of temporal variation. We will conduct a series of studies examining the influences of active riparian zone management on bat populations, begin work on the influence of thinning operations on bats, and commence comparisons of bat utilization of alder-dominated and conifer-dominated riparian zones. The results of these studies will provide a scientific basis for appraisal of management alternatives that may influence bat populations in and adjacent to riparian areas.

Recommended Readings

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Adaptive COPE

PATTERNS OF LARGE WOOD AND STREAM TEMPERATURE IN FORESTED COASTAL STREAMS

Large woody debris and stream temperatures are important parameters affecting the physical, chemical, and biological attributes of Coast Range streams. Large woody debris has received much attention over the past several decades, particularly for its effect on the physical characteristics of stream channels and on the maintenance of fish habitat. Most stream temperature research has focused on the beneficial effects of shade in preventing rapid increases in summertime stream temperatures.

The Coastal Region of the Pacific Northwest is characterized by high rainfall, moderate summer and winter temperatures, mixed sedimentary and volcanic geology, and rapidly growing forests. Although most watersheds originate within the Coast Range Mountains, in the southern portion of the region two large basins, the Rogue and Umpqua, originate in the Cascades. Unlike the northern basins which flow both east (into the Willamette) and west (into the Pacific) from the divide, the large southern basins flow westward from their headwaters in the Cascades. The physical settings of these basins and watersheds, combined with a diverse history of land use practices and natural disturbance regimes, have created and continue to influence the spatial and temporal patterns of large woody debris and stream temperatures in forested streams of the region.

Large Woody Debris Patterns in Forested Coastal Streams

Over the last two decades the role of large woody debris in both aquatic and terrestrial environments of the Pacific Northwest has been the subject of increasing concern. In aquatic environments, such wood affects a wide array of stream ecosystem functions including the occurrence and morphology of pools and gravel deposits, sediment storage and routing, bank stability, and overall channel complexity. Along stream corridors and areas adjacent to streams, large wood also serves as local regeneration sites for conifers. The frequency, species, volume, and other characteristics of large woody debris in the Coastal Region is highly variable and depends upon the characteristics of riparian forests (i.e., species and age class distributions), land use history, landform, and natural disturbance regimes.

A dominant feature of Oregon's coastal areas, in contrast to others of the state, is the prolific regeneration of hardwoods, especially alder (*Alnus rubra*), in riparian zones. In general, the Coastal Region, and particularly the north coast, has a relatively low percentage of conifers in areas adjacent to streams. Historically, harvesting of streamside forests in conjunction with natural disturbances such as fires, floods, and windstorms has served to create and maintain extensive alder-dominated riparian systems throughout forested coastal stream areas of the Pacific Northwest. Since alder is able to rapidly colonize recently disturbed soils and streambanks, it is maintained by frequent disturbances. In addition, alder is more tolerant of inundation and is able to grow in riparian areas where groundwater is relatively close to the surface. For low-elevation riparian zones near the coast, Sitka spruce (*Picea sitchensis*) is also common on relatively wet sites since it is able to tolerate inundation.

Land use practices have had a significant effect on the abundance and distribution of large woody debris in coastal streams. Historically, many of the coastal rivers and estuaries of Oregon contained large amounts of wood that was removed to allow log drives and also boat traffic. Additional wood was removed from smaller coastal streams through splash damming. Timber harvesting, agriculture, and construction of roads and homes along small streams have further affected the presence and characteristics of large wood (including piece length, diameter, and volume—by direct removal or breakage during harvest). In some instances, forest operations may have increased the amount of wood in streams as a result of increased frequency of debris torrents and bufferstrip blowdown.

Landforms have an important influence on large wood patterns in the Coast Range. For watersheds at the northern portion of the coastal mountains, terraces and floodplains generally have a greater alder component than hillslopes. This pattern changes in the southern coastal basins where the relative distribution of conifers and hardwoods on valley floors and hillslopes is generally different, though the differences are not always significant. In addition, in many areas

narrow channels have more recruitment of large wood than flatter channels as a result of larger trees growing on hillslopes than on floodplains.

Other characteristics of streamside forests also affect the in-channel large wood component. Generally, the relative proportion of in-channel conifer loadings increase with higher levels of riparian conifer basal area. Since most large wood comes from areas adjacent to streams, the distance from the stream channel to the sources of large wood is an important variable; source distances of large wood generally depend on geomorphology and tree height and species. In western Oregon streams, approximately 80 percent or more of the in-channel hardwood debris originates within 10 m of the stream, as compared to 50 percent or more of conifer debris. Most large wood recruitment occurs from beyond 1 m of the streambank, indicating that much of the wood in streams is delivered by processes other than bank erosion.

The age class of the forest adjacent to the stream also influences in-channel wood characteristics. However, it is difficult to determine a precise relationship between stand age and debris loading in stands younger than 120 years since the loading rates are influenced by residual debris. Depending on the age of the stand adjacent to the stream, the volume of wood in coastal streams varies from an average of 30 m^3 per 100 m of channel length for approximately 50 year-old stands, to 46 m^3 per 100 m for 80 to 150 year-old stands, to 96 m^3 per 100 m for stands older than 200 years (Figure 1).

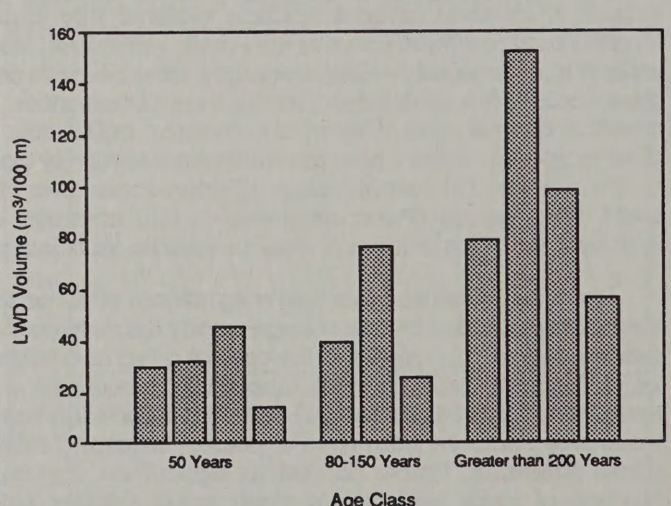

Figure 1. Total volumes of large woody debris by age class for forested coastal streams in Oregon and Washington. Each bar represents a different study of streams within the indicated age class.

The majority of the large wood in coastal streams is coniferous, with hardwood volume comprising from approximately 5 to 15 percent of the total volume. In areas deficient of coniferous riparian species, due to previous disturbance or harvest, hardwoods represent an interim source of large wood before significant recruitment by conifers. Increased hardwood recruitment, generally from riparian hardwoods, tends to occur 40 to 60 years after harvest. In contrast, the recruitment of coniferous wood tends to begin about 100 years following harvest. Hardwood species tend to contribute relatively smaller pieces than conifers and decay more rapidly. Thus, the importance of hardwood debris is likely of less significance for long-term channel stability, sediment routing, and fish habitat.

In the Oregon Coast Range, the effects of streamside harvesting and other land use practices, in combination with forest regeneration and succession, have reduced the occurrence and magnitude of large woody debris in coastal streams. Since over 65 percent of the forest stands on private land in Oregon are between 20 and 100 years old and were harvested prior to the forest practices rules of the 1970s, there are many miles of stream in which the large wood component has been significantly altered due to past practices. Though current riparian harvest practices protect direct removal of in-channel wood, they allow a significant reduction (often greater than 60 percent) in the number of streamside conifers, which represent future sources for in-channel large wood in western Oregon. This reduction of riparian conifers effectively reduces the potential for future recruitment and will essentially maintain diminished levels of large wood in Oregon's coastal streams for many decades into the future.

Temperature Patterns in Coastal Streams

The temperature of forested streams is a critical parameter affecting a wide array of chemical and biological processes and the general habitat characteristics of in-stream organisms. Although stream temperatures are a result of several energy transfer processes, they generally reflect seasonal patterns of net solar radiation in conjunction with the energy transfer processes of evaporation, convection, conduction, and advection. Factors that modify these energy transfer processes (e.g., riparian vegetation, topographic shading, stream orientation, stream width and depth, and elevation) also influence stream temperatures.

The Coastal Region of Oregon, like other regions of the state, generally exhibits an inverse relationship between elevation and summertime stream temperatures, but the pattern changes somewhat as streams and rivers approach the ocean. In most regions, stream and air temperatures increase with decreasing elevation. However, for streams that are below approximately 33 m of elevation and are approaching the ocean, the local effects of the summer maritime climate overcome the downstream warming trend and temperatures actually decrease with decreasing elevation (Figure 2A). From the northern to the southern portion of the Coast Range, a latitudinal gradient of increasing August stream temperatures also occurs (Figure 2B).

Because stream temperatures vary with elevation and location within a basin, individual basins and watersheds tend to have characteristic patterns of downstream temperatures that are influenced by the characteristics of the riparian forests. For example, in the central portion of the Coast Range, Lobster Creek is between 8.5 and 14 km from the ocean and ranges from approximately 50 m in elevation at the mouth to 1,000 m at the divide. Stream temperatures vary within the basin, with the most significant differences between the upper and lower elevation streams. As indi-

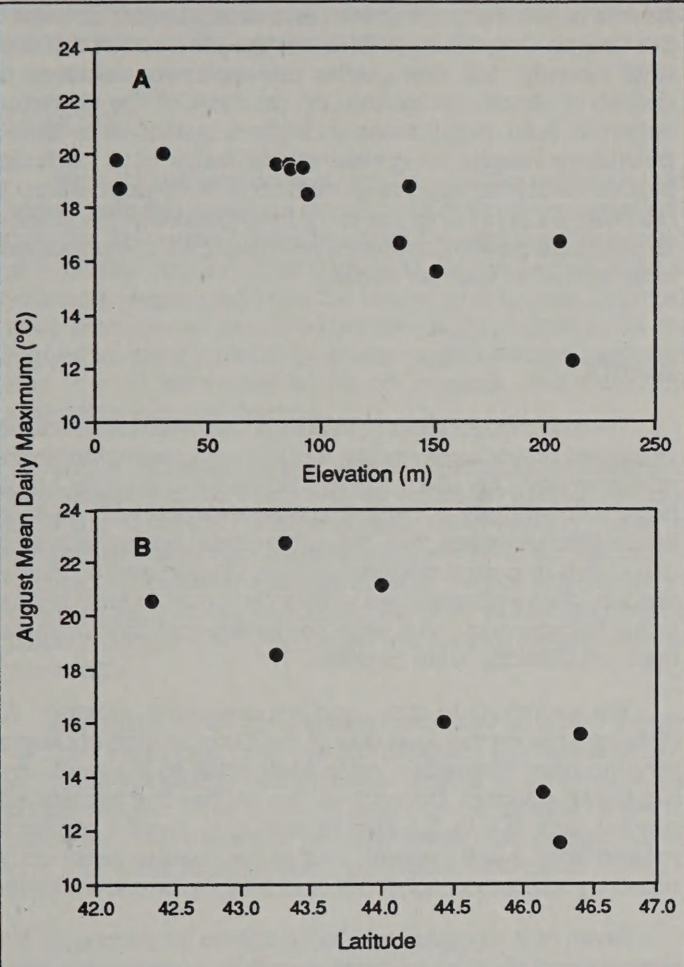

Figure 2. August mean daily maximum stream temperatures in coastal Oregon streams (A) as a function of elevation for north coast basins and (B) as a function of latitude for streams less than 33 m in elevation.

cated in Figure 3, there is less temperature difference between the middle and lower portion of the basin; therefore, by the time the stream has reached the unconstrained reaches, most of the heating has occurred.

A relatively early study in the central Coast Range (the Alsea Watershed Study) was one of the first to examine the effects of timber harvest on stream temperatures. Watershed studies prior to that had mainly focused on the effects of harvesting on sediment and runoff production. The Alsea Watershed studies found that large increases in summer stream temperatures could result after harvest. Furthermore, these studies indicated that bufferstrips were an effective means of preventing increases in summertime stream temperature. Because of the moderating influences of the ocean on the coastal climate and the rapid regrowth of vegetation, bufferstrip widths of approximately 15 to 20 m appear to provide shading levels in the Coast Region that are equivalent to shading provided in unharvested old-growth stands; for Cascade Range streams, bufferstrip widths of approximately 35 to 40 m wide appear to provide shading equivalent to shading in unharvested old-growth stands.

Subsequent studies in the Steamboat drainage indicate that summertime stream temperatures that were elevated

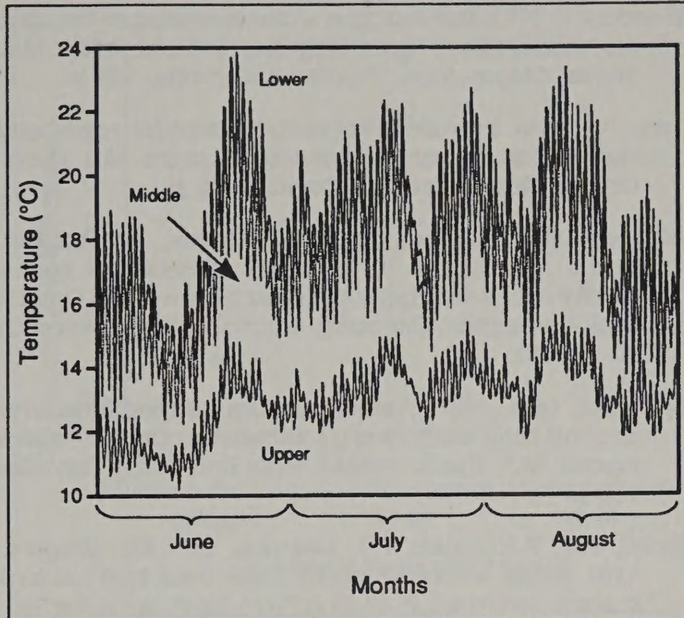

Figure 3. Stream temperatures through time (during 1992) for sites in lower, middle, and upper Lobster Creek.

following streamside harvesting and debris torrents decrease with the reestablishment of vegetation in disturbed riparian areas and with the placement of bufferstrips in areas subsequently harvested. Most of the observed decreases in summertime stream temperatures have been in tributaries.

Conclusions

The Oregon Coast Range, though often considered a contiguous region, varies considerably from north to south and west to east in relation to the topography, climate, and the characteristics and successional patterns of riparian forests. This variability has created complex patterns of large woody debris and stream temperatures that have been further affected by land use history. Recent decades have brought changes in the protection of stream ecosystem functions through forest practice legislation. Current proposed forest practices, if enacted, will be a major step towards providing for future sources of large wood.

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STATUS OF RESIDENT COASTAL CUTTHROAT TROUT POPULATIONS IN MATURING SECOND-GROWTH BASINS OF THE OREGON COAST RANGE

Introduction

With dwindling opportunities to harvest previously unlogged stands in western Oregon and with maturing second-growth stands becoming a substantial part of the landscape, the rate at which second-growth forests are harvested is expected to increase in the near future. Forest stands logged before the adoption of Oregon's Forest Practice Act in 1972 were generally harvested without the standards prescribed today. We ask whether basins previously harvested without riparian buffers represent a unique component of the western Oregon landscape, and whether the prescriptions for stream and streamside treatments based on experience with harvesting previously unlogged stands are appropriate for harvesting these second-growth stands.

A primary objective of this study was to characterize the status of resident cutthroat trout that are at least 1 year old (age 1+ or older) in streams where logging occurred 20 to 60 years ago. Resident cutthroat trout are often the only species of fish occupying first- and second-order streams in the Oregon Coast Range. Because the presence of fish (and until recently, fish size) guides management decisions on degree of stream protection, an analysis of the pattern of cutthroat trout populations in logged basins over time is potentially helpful for assessing the status of a particular basin's ability to support a cutthroat trout population. In addition, such an analysis may help generate the kinds of prescriptions needed to ensure maintenance of a population after a second harvest event.

Methods

We searched for streams in basins that were either entirely unlogged or homogeneously logged with respect to timing and intensity. An ideal logged basin for our study would have been entirely cut within a 5-year period with no riparian buffers provided. We did not sample basins with staggered cuts or partial riparian buffers. We focused on stream reaches above barrier-sized waterfalls to ensure that anadromous salmon and trout were excluded and that cutthroat trout populations were resident.

We sampled 16 first- and second-order streams. All streams were on the west side of the Coast Range of Oregon ranging from tributaries of the Siletz River to the north and Big Creek (Lincoln County) to the south. The watersheds ranged from 0.5 to 3.5 km^2 in size, and stream gradients ranged from 2 to 8 percent. Half of the streams were dominated by sandstone substrate and half by basalt substrate.

Seven of the basins were logged 20 to 30 years ago, five were logged 40 to 60 years ago, and four were not logged. The unlogged stands are probably representative of the fire history prevalent in the mid-coastal region of Oregon. These unlogged basins had 125 to 150 year-old forest stands with occasional older, remnant trees present.

We conducted a habitat survey on each study stream during summer low-flow periods between 1991 and 1993. Surveys included collection of data on riparian vegetation and large woody debris (LWD). LWD was defined as downed wood at least 1 m in length, at least 30 cm in diameter, and with some part of the piece within the active channel of the stream. We identified stream habitat types (e.g., pools, glides, riffles, and finer gradations within these basic habitat types) and measured the length, width, and depth of the stream within each habitat type.

Stream habitat types served as strata for survey sampling of age 1+ or older cutthroat trout conducted within 2 to 5 days after a habitat survey. We used a backpack electrofishing unit and a pass-removal method to collect fish in randomly selected habitat units. Where needed, we placed block nets at one or both ends of a habitat unit to prevent fish from entering or escaping from the unit during sampling periods. We conducted at least two removal passes on each habitat unit sampled. Removal passes were continued until no age 1+ or older cutthroat trout were caught on the last pass. We recorded data on length and weight for each fish captured. Total cutthroat trout biomass for a stream reach was calculated for each habitat type and summed over all habitat types identified. Biomass per unit area (g/m^2) was

derived by dividing the estimated total biomass by the total surface area of the stream in the reach.

Results

Biomass per unit area of age 1+ or older cutthroat trout varied with the presence and timing of forest management activity. Unlogged basins consistently supported low levels of cutthroat trout biomass (Figure 1). Basins logged 20 to 30 years ago supported both the lowest and highest cutthroat trout biomass encountered in the study, resulting in the highest levels of variability. Basins logged 40 to 60 years ago had low to moderate levels of biomass and moderate variability among streams.

Basins that were logged without prescriptions for streamside buffers had more hardwoods within the riparian canopy than did unlogged basins (Figure 2). Overstory cover of conifers averaged 55 percent (range = 30 to 80 percent) in riparian canopies of unlogged basins, 12 percent (range = 0 to 30 percent) in basins logged 20 to 30 years ago, and 29 percent (range = 10 to 45 percent) in basins logged 40 to 60 years ago.

Streams in unlogged basins and those in basins logged 40 to 60 years ago had low to moderate quantities of LWD with little variability across basins (Figure 3). Streams within basins logged 20 to 30 years ago can be grouped into two categories, three streams with low levels (<15 pieces/100 m) and four with high levels (>35 pieces/100 m) of LWD.

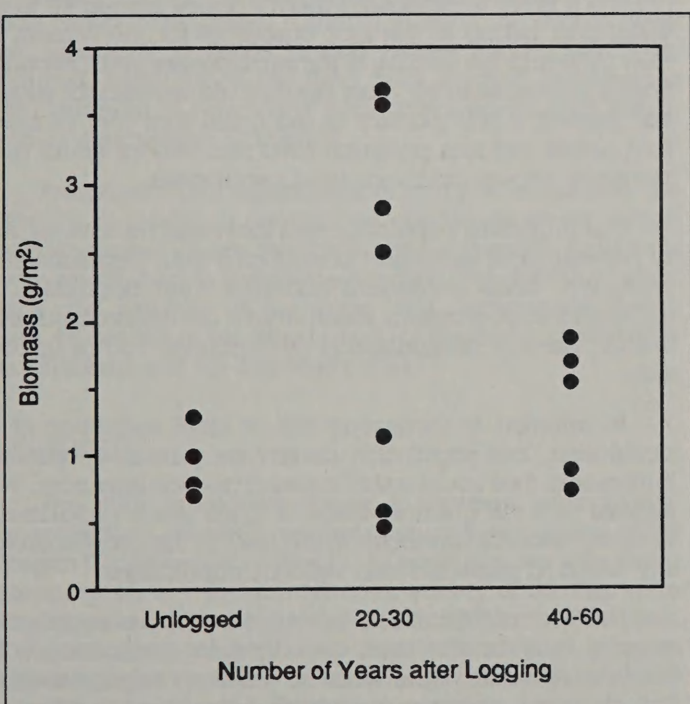

Figure 1. Summer low-flow densities of age 1+ or older cutthroat trout in 16 streams that drain the west side of the mid-Coast Range of Oregon, 1991-93. The streams have been segregated into three classes based on forest management activities and age of the forest stand within their basins.

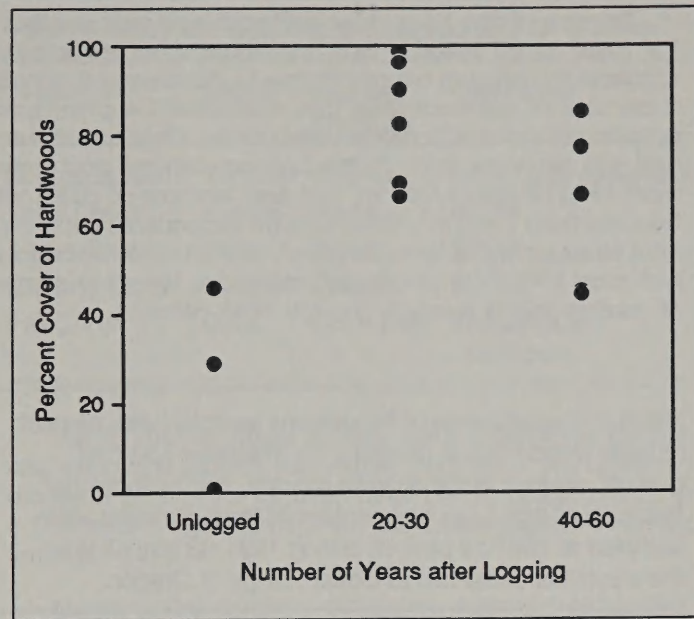

Figure 2. Percent hardwood in riparian canopies for 16 streams that drain the west side of the mid-Coast Range of Oregon, 1991-93. The streams have been segregated into three classes based on forest management activities and age of the forest stand within their basins.

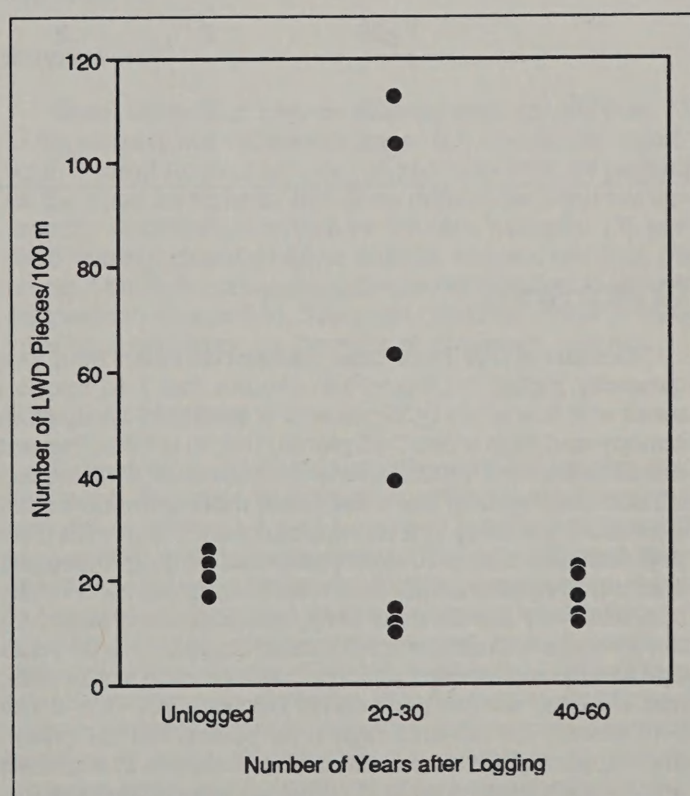

Figure 3. Frequency of large woody debris (LWD) for 16 streams that drain the west side of the mid-Coast Range of Oregon, 1991-93. Each piece was ≥1 m in length and ≥30 cm in diameter. The streams have been segregated into three classes based on forest management activities and age of the forest stand within their basins.

Biomass of age 1+ or older cutthroat trout was less than 1.4 g/m^2 in all streams that had more than 35 percent conifer in the riparian canopy (Table 1). All streams that had a biomass of cutthroat trout that exceeded 1.4 g/m^2 had riparian canopies with ≤35 percent conifer. Only one stream had ≤35 percent conifer in the riparian canopy and more than 15 LWD pieces/100 m, but had biomass of cutthroat trout less than 1.4 g/m^2. Three streams supported a cutthroat trout biomass higher than 2.5 g/m^2, and all of these streams had high LWD (>35 pieces/100 m) and a low percentage of conifers in the riparian canopy (<35 percent).

Table 1. Classification of 16 streams sampled with respect to large woody debris (length ≥1m, diameter ≥30 cm), percent conifers in the riparian canopy, and biomass per unit area of age 1+ or older cutthroat trout. Streams were sampled at low-flow periods during 1991-93 and all drain the west side of the mid to Coast Range of Oregon.

Number of large woody debris pieces per 100 m	Percent conifers in riparian canopy	Number of streams with cutthroat having a biomass of --	
		≤1.4 (g/m^2)	>1.4 (g/m^2)
≤15	>35	1	0
	≤35	2	2
>15	>35	5	0
	≤35	1	5

Conclusions

Biomass of age 1+ or older resident cutthroat trout was generally higher (>1.4 g/m^2) in streams that had riparian zones with low levels (≤35 percent) of conifer in the riparian canopy and high levels (>15 pieces/100 m) of LWD. Percent hardwood in the riparian zone and level of LWD varied substantially among the three forest management classes examined, resulting in a dynamic picture of cutthroat trout populations in basins 20 to 60 years after logging. Unlogged basins had riparian zones that were dominated by conifers, had relatively low levels of LWD, and supported relatively low biomass of cutthroat trout. Basins logged 20 to 30 years ago had riparian zones that were dominated by hardwoods, had a highly dichotomous distribution of LWD, with a low (<15 pieces/100 m) and high (>35 pieces/100 m) group, and supported the lowest and highest biomass of cutthroat trout encountered in the study. Basins logged 40 to 60 years ago had low to moderate levels of LWD, had moderate levels of hardwood in the riparian canopy, and supported low to moderate biomass of cutthroat trout. Mechanisms that may explain variation in biomass of cutthroat trout include the differences in scour and cover afforded by LWD and the differences in light and nutrient inputs afforded by deciduous versus conifer trees in the riparian zone.

Natural disturbances and management activities that lead to lowered levels of LWD such as wildfire and stream cleaning, respectively, have resulted in reduced cutthroat trout populations in headwater streams of the Oregon Coast Range. Low levels of LWD were found in three of the seven basins logged 20 to 30 years ago, presumably as a result of stream cleaning activities and/or debris torrents. Biomass per unit area of cutthroat trout in basins that were logged 20 to 30 years ago but left with low levels of LWD were quite similar to basins that were unlogged but burned 125 to 150 years ago.

However, prospects for future recruitment of LWD differ among basins depending on prior forest disturbance and management activities. Although levels of LWD input from riparian stands dominated by hardwoods in the basins logged 20 to 30 years ago will probably increase in the near future, the standing crop of LWD could well decrease, owing to the rapid decay of downed hardwood and the continued decline of conifer LWD remaining from before or during the logging event. In contrast, both the levels of input and the standing crop of LWD are expected to increase in the unlogged basins as the conifer-dominated riparian zones mature.

The period between 40 to 60 years after logging appears to be a time of transition for resident cutthroat trout populations from the elevated levels of biomass associated with the first 30 years after logging to the decreased biomass in basins undisturbed for 125 years or more. Stream cleaning was infrequent 40 to 60 years ago and small streams were often left full of slash and unmerchantable timber. As with basins logged 20 to 30 years ago, the trajectory for levels of LWD is likely to be downward for basins logged 40 to 60 years ago, owing to the lack of sources for recruitment of new LWD and the decline of remnant conifer LWD. Because basins logged 40 to 60 years ago are old enough for potential harvest, it is important to recognize that any practice that further reduces potential LWD recruitment could substantially impact cutthroat trout populations.

The minimum population size that must be maintained to prevent local extinction of cutthroat trout populations is unknown. Once a resident cutthroat trout population is extirpated from a stream reach above an anadromous fish barrier, natural recolonization by cutthroat trout is impossible.

In addition to increasing risk of local extinction of a population, low population density may result in genetic bottlenecks that could result in loss of genetic resources. We believe that the greatest value of these small populations to future resource management is held in the genetic diversity found in these isolated resident populations.

Habitat conditions that prevail 60 or more years after logging may be the most important for maintenance of resident cutthroat populations in western Oregon streams. Unfortunately, we were unable to determine the status of resident cutthroat trout populations in watersheds that were logged more than 60 years ago. It is not known to what levels LWD will decline before new sources of conifer LWD can be regenerated, but it will be highly contingent upon future riparian management and intensity of natural disturbances such as floods.

Our results suggest that providing streamside buffer zones in second growth basins may not be adequate to maintain cutthroat trout habitat and productivity because the riparian vegetation existing in a prescribed leave area may not provide adequate future resources for this species. A riparian management plan that severely restricts or excludes potential regeneration of conifers in streamside areas would limit future sources of LWD that are important elements of cutthroat trout habitat. On the other hand, a riparian management plan that promotes high conifer densities but limits the maturity of these conifers, such as by allowing selective cutting of conifers within streamside areas, could limit the productivity of cutthroat trout as a result of maintaining high levels of shade and low levels of nutrient input. It must be emphasized that these tentative conclusions are based on studies of small stream systems that have potential for closed canopies and that drain extensively logged basins where riparian buffers were not provided. Data analysis is still in progress and conclusions may be modified at the end of the study, anticipated in about 1 year.

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SURVIVAL AND GROWTH OF CONIFERS RELEASED IN ALDER-DOMINATED COASTAL RIPARIAN ZONES

Introduction

Many coastal riparian zones have few conifers to provide persistent structural material to enhance stream habitat, especially in areas logged before buffer strips were required. Disturbance resulting from logging encouraged establishment of hardwood dominated stands with exclusion or suppression of conifers.

Adaptive COPE established a study to determine the efficacy of releasing overtopped conifers in Coast Range riparian zones that are dominated by hardwoods. Field trials were established to determine survival and growth of seedlings and saplings in managed and unmanaged conditions. In this article we report results of the study 3 years after its establishment for five study sites.

Methods

Five study areas were chosen to represent typical riparian zones from the north, central and southern regions of the Oregon Coast Range (Table 1). At each site, we selected a stream reach of 1 to 3 km where a variety of conifers were overtopped by a young alder stand. Within the five sites, 261 overtopped conifers were selected for study. Selected trees ranged from 0.5 to 15 m in height, and from 0 to 10 cm dbh. The selected Douglas-fir, western hemlock and western redcedar seedlings and saplings were randomly chosen to be released by cutting, released by girdling, or not released. To release trees, all alders surrounding the conifer within a circle with a radius equal to 1/4 the total height of the alder were either felled by chainsaw or girdled with an ax.

Table 1. Study site locations of released riparian conifers.

Drainage	County	Nearest town	Ownership
Nestucca River	Yamhill	Beaver	Willamette Industries
Tobe Creek	Benton	Alsea	B.L.M
J-Line Creek	Lane	Alsea	B.L.M.
Halfway Creek	Douglas	Elkton	B.L.M.
Fall Creek	Coos	Coos Bay	Weyerhauser Company

Height and diameter growth were determined the second and third growth years after treatment. We analyzed diameter growth for all trees over 1.4 m, breast height ($n = 177$) and height growth for all undamaged, surviving trees ($n = 167$).

Survival and diameter data were normally distributed. We log transformed height growth data to approximate a normal distribution. We conducted two way analyses of variance (species and treatment) for survival, diameter and height growth and we used Tukey's Studentized Range test to separate significant means using an alpha value of 0.05.

Results

Survival

Mean survival of trees at different sites ranged from 73 to 95 percent but differences were not statistically significant. Overall survival of trees ranged from 79 to 89 percent for the three treatments, but these differences were not statistically significant. Survival for western redcedar (95 percent) was significantly higher than for western hemlock (75 percent) but was not significantly greater than for Douglas-fir (78 percent) (Figure 1A). The most common cause of mortality was herbivory by beavers or mountain beavers.

Growth in Diameter

Diameter growth varied significantly by species and treatment. Diameter growth of conifers released by total removal of alders (1.3 cm) exceeded unreleased (control) conifers (0.5 cm), but was not significantly different than growth of conifers released by girdling surrounding alders (1.1 cm). Mean diameters were not found to be significantly different between species, due in part to high levels of variation within species. Release treatments resulted in a two-fold increase in diameter growth for Douglas-fir and western hemlock and for western redcedar released by total removal of alders (Figure 1B). The response of western redcedar to release by girdling alders was moderate due to heavy browse by ungulates.

Growth in Height

Overstory treatment significantly influenced height growth. Mean growth for each species was nearly two times greater when subjected to overstory treatment, except for

heavily browsed western redcedar in the girdled treatment (Figure 1C). Height growth at the end of year three was not significantly different between species or sites. Annual height growth for the three species was modest, ranging from 35-37 cm.

Visual observation of released conifers left no doubt that trees surviving 3 years after treatment benefited greatly by both girdling and felling. Crowns of released conifers were filling out and foliage was healthy and green.

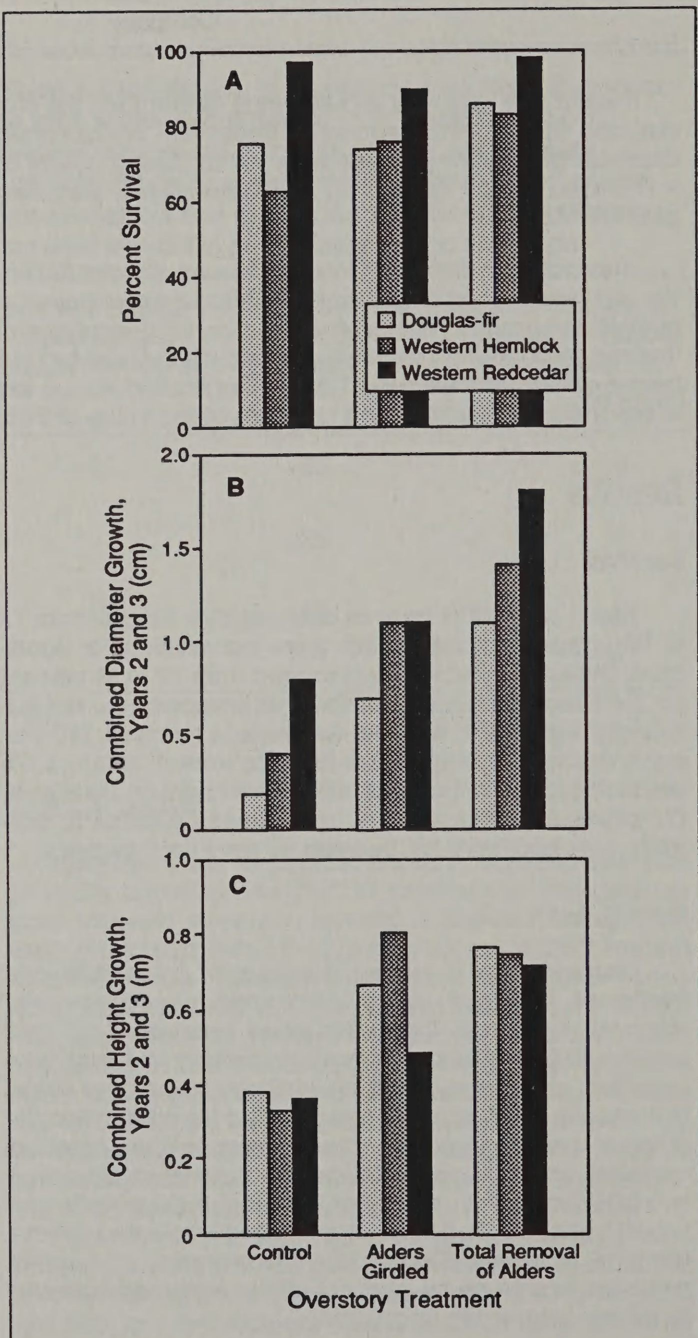

Figure 1. (A) Tree survival 3 years after release treatment. (B) Diameter growth of released conifers during the second and third growing seasons after release treatment. (C) Height growth during the second and third growing seasons after release treatment.

Discussion

Many factors contributed to the variation in survival and growth. Each site or portion of a site could be subject to different levels of herbivory by beavers, mountain beavers, or ungulates. Alders that were girdled, sometimes dropped limbs or fell on released conifers. In some areas, understory vegetation that was partially suppressed by the hardwood canopy, appeared to respond in growth and vigor to the release treatments.

Some released conifers may have suffered from release "shock," a condition of reduced growth following exposure to more intense light. This was observed for western hemlock saplings in the Cascade Mountains when shelterwood cuttings greatly increased the light penetration to the understory (see Tucker and Emmingham, Recommended Readings). A similar growth reduction has been observed for Sitka spruce and Douglas-fir saplings after a 14-year-old stand of alder was thinned.

Survival over three years in the untreated stands for western hemlock (63 percent) and Douglas-fir (76 percent) was low compared to western redcedar (97 percent). This suggests that release operations for western hemlock and Douglas-fir should have a higher priority than those for redcedar.

Despite the higher survival of western redcedar and the high resistance of its heartwood to decay in the stream, western redcedar may not be the preferred species for release. It can survive extreme and repeated clipping by herbivores and maintain diameter growth. However, height growth, especially of trees less than 2 m tall, was severely impacted by the herbivory, thus delaying its recruitment into the overstory. Unless a conifer reaches an emergent position over the hardwood canopy it will not grow to the large proportions needed to add meaningful structure to the stream.

Of the three species included in this trial, western hemlock appears to be the best suited to release, because of its shade tolerance and low palatability to herbivores. Its wood is, however, less decay resistant than either Douglas-fir or western redcedar.

In terms of survival and height growth, the response of Douglas-fir to release is comparable to that of western hemlock and western redcedar; however, its response in diameter growth is limited. Other studies have shown that Douglas-fir becomes etiolated (slender or elongated) when growing in a shaded environment. Thus, under these conditions, Douglas-fir is vulnerable to snow or ice damage and is easily pinned by falling debris. Despite these failings, we believe that Douglas-fir should be considered a viable candidate for release for several reasons. In some areas it is the only conifer species present. It does respond positively to release, and it often emerges over hardwood stands naturally after long time periods. Release treatments may be modified to give it more space and resources. Douglas-fir heartwood is quite decay resistant and can provide excellent and longlasting stream structures.

It is important to understand the limitations of our release treatments in fully exploring the response of conifers to release. These treatments provided a relatively small

window for release. The gap created in the canopy was small, and considerable canopy closure by lateral expansion of alder crowns occurred in just 3 years. The fact that even Douglas-fir survived well, and responded in both diameter and height growth indicates that further testing is warranted. More release in the form of bigger gaps, more general thinning, and understory vegetation control, could improve the response of Douglas-fir.

More liberal release treatments would probably benefit the shade tolerant species also. Released trees grew only about 35 cm per year in height. Hemlocks that were free to grow in these relatively rich sites could be expected to grow 1 to 2 m per year. Fully released trees should achieve 1/2 to 2/3 of their maximum potential height growth. In underplanting trials near Astoria, western hemlock planted in a thinned alder stand grew from 0.5 to 1.0 m per year (Emmingham et al., Recommended Readings).

The results of previous studies suggest that managers should consider operational treatments resembling thinnings rather than gap creation (see Recommended Readings). Thinnings provide a shaded environment with lots of side light; western hemlock responds well to those conditions. Such treatments can result in a high degree of structural diversity within a stand and can create a multi-layered canopy.

In determining the degree of release required for conifers to emerge above the hardwood canopy, knowledge of patterns of relative height growth can be useful. Alder height growth rates taper off at a relatively early age (e.g., 25 years), while rapid conifer growth continues for many decades. Thus, conifers emerging above a hardwood canopy can build crown, and maintain excellent diameter growth rates. Released conifers should accelerate growth once they surpass the hardwoods in height.

Summary

Release of conifers in small clearings or partially cut riparian zone alder stands appeared to be a viable option for enhancing conifer growth, thereby contributing to stream rehabilitation. Either gap creation or thinning appeared to be good operational approaches to promoting conifer development in stream side forests. Duration of beneficial effect of release depends on the age and density of residual alder and on site conditions. Shade tolerant species responded to best release, but Douglas-fir was also improved when released, and it should be considered for release treatments. Continued study is needed to determine the duration of the effects resulting from release treatments.

Recommended Readings

Emmingham, W.H., M.C. Bondi, and D.E. Hibbs. 1989. Underplanting western hemlock in red alder thinning: early survival, growth and damage. New Forests 3:31-43.

Hibbs, D.E., W.H. Emmingham, and M.C. Bondi. 1989. Thinning red alder: effects of method and spacing. Forest Science 35:16-29.

Tucker, G.F., and W.H. Emmingham. 1977. Morphological changes in leaves of residual western hemlock after clear and shelterwood cutting. Forest Science 23:195-203.

W.H. Emmingham and Kathleen Maas,
Adaptive COPE

SELECTED POSTER ABSTRACTS

Winner of the Most Clearly Presented Information Poster Award:

HARDWOOD SILVICULTURE COOPERATIVE

Interest in managing hardwood species to ensure future supplies of hardwood lumber, for species diversity, and as an alternative to conifers in disease pockets, is increasing in the Pacific Northwest. In 1991, the hardwood industry in Washington and Oregon employed over 7000 people, providing an annual income of just under $200 million.

The Hardwood Silviculture Cooperative (HSC), based at the Oregon State University College of Forestry, conducts high priority research on hardwood species and mixed hardwood/conifer stands in the Pacific Northwest. The goals of the cooperative are to:

- develop guidelines for stand establishment and management,
- synthesize and disseminate information on hardwood resources,
- encourage and cooperate in fundamental research on the biology of hardwood species as a component of forest systems,
- facilitate integration and cooperation among Pacific Northwest organizations concerned with the hardwood resource and its management.

Participants in the cooperative include members of industry, public agencies, and educational institutions. Priorities for cooperative activities are set by members and are carried out by cooperators and Oregon State University staff. General Activities of the cooperative include:

- Silvicultural research on hardwood species,
- Publications,
- Information and technology transfer, through written materials, workshops, and field tours.

Some specific examples include working with forest nurseries to develop quality alder growing stock, helping land owners and managers identify appropriate sites and treatments for managing hardwoods, and the publication of guides for the management of hardwood species.

The two main research priorities at the present time are the Red Alder Stand Management Study and the Alder Wood Quality Study.

The Red Alder Stand Management Study was initiated in 1988. Its goal is to develop an information base with which to model growth and yield in red alder in managed stands, as well as the effect of various planting and thinning regimes on growth, yield and wood quality. This will be accomplished through manipulation of a series of natural stands (Type 1 installations) and plantations (Type 2 installations) over a range of physiographic regions and site qualities. In addition, mixtures of red alder and Douglas-fir will be planted (Type 3 installations, nine are planned) to examine the interaction of these two species growing together.

The Alder Wood Quality Study is being conducted in two parts. The Lumber Recovery Study was completed in 1992. This was a cooperative study with the Pacific Northwest Research Station's Timber Quality Project in which the HSC supplemented their log-to-lumber and grade recovery project with tree and stand data. This study found that the dollar value from alder trees was from high-grade lumber, primarily in the butt log (the first three meters).

The second part of the study, tree growth and self-pruning as a function of spacing and thinning, has begun this year. Three objectives for the current effort are to:

- Develop equations that describe branch growth, branch mortality, and crown lift as a function of spacing,
- Quantify the effects of spacing on stem taper,
- Examine the effects of thinning on branch, height, and bole diameter (taper) development.

Data is being collected from research plots with a well known history of spacing.

David Hibbs and Karl Buermeyer,
OSU Forest Science Department

Winner of the Best Overall Display Poster Award:

FOREST ENVIRONMENT AND UNDERSTORY VEGETATION BEFORE AND AFTER COMMERCIAL THINNING

Dense, young, even-aged stands of Douglas-fir lack the multi-storied structure and biological diversity typical of old-growth forests. In cooperation with Oregon State University, three commercial-thinning treatments and an unthinned control are being established at three coastal Oregon sites to see if structural development can be accelerated through silvicultural manipulation. The thinning treatments were applied in 1992 at one of those sites near Mapleton, Oregon, where both preharvest and initial postharvest measurements have been completed.

The unthinned stands had 280 TPA (trees per acre) and understory light levels of two to three percent of full sunlight. Thinning to 100 TPA increased available light to 20 percent, and understories of the stand thinned to 30 TPA had 63 percent of full sunlight. Thinning did not affect the amounts of exposed soil or large, woody debris; but it substantially increased the depth, cover, and volume of fine slash (<5 cm in diameter).

The occurrence, abundance, and height of each of the 12 shrub and 20 herb species present were measured before and after thinning. Logging damage reduced shrub heights, shrub cover, and the cover of most herbs in the thinned stands. Several new herb species began to appear in 1993.

Equal numbers of 2-year-old Douglas-fir and western hemlock seedlings were planted the first winter after logging in half of the areas studied in each stand to evaluate the effect of understory trees on structural development. First-year survival exceeded 90 percent for both species in each of the thinned stands. Survival was 60 percent for western hemlock and zero for Douglas-fir in the unthinned control.

Don Minore, Sam Chan, Pete Owston, Howard Weatherly, Dan Mikowski, Chuck Acton, and Valerie Banner,
USDA Forest Service, PNW Research Station, Corvallis, OR

USE OF INVASIVE TREATMENTS TO CONTROL LAMINATED ROOT ROT IN LIVING DOUGLAS-FIR: EFFECTS ON TREE GROWTH AND SURVIVAL

We report on an experimental approach to control laminated root rot (*Phellinus weirii*) — injection of biocides or chemical fumigants into living trees — and the effects of these biocides on subsequent growth of Douglas-fir trees. Fifteen trees were randomly assigned to each of nine treatments. Two fumigants chosen for treatment — chloropicrin and methylisothiocyanate (MITC) — were each applied at several dosages; while Vorlex (active ingredient — MITC) was applied at one dosage.

During the 9-year study period the control treatment had 80 percent survival. The higher dosage chloropicrin treatments caused substantial mortality (<30% survival). Some treatments increased survival; the lowest dosage chloropicrin treatment and all MITC treatments had 100 percent survival. All of the injection treatments killed some tissues around the injection sites. Death of the vascular cambium was more common than death of the cork cambium resulting in fluted lower boles. The lowest dosage chloropicrin and the three MITC treatments resulted in the least damage.

Height growth was greatest for untreated trees; however, growth in the lowest dosage chloropicrin and MITC treatments was not significantly less. Upper stem growth

was greatest for the untreated trees and least for the high chloropicrin and Vorlex treatments. At the same dosage, chloropicrin and Vorlex had significantly greater negative effects on tree height and diameter growth than MITC.

MITC increased survival of infected trees, and at low dosages was effective in reducing infection levels without causing significant growth reductions; future trials with MITC are clearly warranted.

Connie Harrington,
USDA Forest Service, PNW Research Station,
Olympia, WA
Walter G. Thies,
USDA Forest Service, PNW Research Station,
Corvallis, OR

ESTABLISHMENT AND REGENERATION OF SALMONBERRY AND SALAL IN THE COAST RANGE FORESTS OF OREGON

We examined seedling establishment, clone architecture, and clone population dynamics of salmonberry (*Rubus spectabilis* Pursh.) and salal (*Gaultheria shallon* Pursh.) in the Coast Range forests of Oregon.

Seedling establishment of both species was affected by overstory density. Seedling survival was greatest in thinned stands whereas neither species survived in unthinned stands of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco). Salal seedling establishment was greater on rotten logs than on other substrates.

Clones and clone populations were affected by overstory density and species composition. The largest salmonberry clones, systems of below-ground rhizomes and aerial stems, were found in red alder (*Alnus rubra* Bong) stands. Salal clones were largest in thinned stands of Douglas-fir. Rhizome and aerial stem densities were greatest in clearcuts whereas dense overstories greatly reduced the size and vigor of clones. Both species appear to maintain a persistent cover and an uneven-age aerial stem population structure by seasonal generation of new stems. Management implications are discussed.

David W. Huffman,
OSU Forest Resources Department

CONCEPTS AND TOOLS FOR ESTIMATING THE EFFECTS OF POLICES ON STREAM AND WILDLIFE HABITAT AND ECONOMIES OF THE OREGON COAST RANGE PROVINCE

This study examines the Oregon Coast Range as a subregional ecosystem that includes public and private policies, landscape ecosystems, and local economies. Our overall goal is to develop and evaluate concepts and tools to visualize and understand patterns and dynamics of large ecosystems and analyze the economic and biological consequences of different forest policies at a province level. We have begun to collect and analyze data to examine the effects of land use and environment on patterns and dynamics of vegetation, wildlife habitat, fish habitat, and local economies. To date, classification of a Thematic Mapper image shows marked gradients in vegetation in response to environment and that federal, state and private landowners create different patterns of clearcuts on their lands.

We plan to build models that (1) relate changes in land use and decisions to cut trees to type of owner, landscape location, and economic climate, (2) predict vegetation succession and tree growth for different Coast Range environments, and (3) relate habitat quality for selected wildlife species and stream habitat to patterns of vegetation and land use. We will then test hypotheses about effects of different scenarios of forest policies on landscape patterns, willife habitat, steam habitat and local economies. Some scenarios will include disturbance (logging) frequencies and patterns and types of surviving vegetation that span the range of pre-settlement fire disturbance regimes.

Joseph E. Means, Thomas A. Spies, and
Warren Cohen,
USDA Forest Service, PNW Research Station,
Corvallis, OR
Norm Johnson, and Scott Splean,
OSU College of Forestry

SOUND APPLICATION OF FIRE ON OREGON COASTAL LANDS

Prescribed fire is a valuable tool in the management of natural resources in the coastal areas of Oregon. Prescribed fire can be used to improve reforestation, reduce fire hazard, and improve rangeland characteristics. It has also been used to perpetuate certain fire-evolved ecosystems. Unfortunately, smoke generated from controlled burning is unpopular with the public and is contrary to current State and Federal laws. Although smoke emissions from prescribed burning in Oregon have decreased by 30 to 50 percent in the last decade, much of the public considers any smoke "too much smoke." They are concerned with both the visibility impairment associated with smoke and the possibility of subsequent health hazards. The Clean Air Act mandates that all forest management activities utilize the best available control technology to minimize pollution.

The Fire and Environmental Research Applications Group (FERA), a research, development, and application team in Seattle, has completed three computer software products to assist land managers in applying the best available control technology for smoke during prescribed fires on coastal Oregon lands. The products are (1) CONSUME, an interactive, user-friendly model for fire managers to predict fuel consumption; (2) SMSINFO, a Paradox-based processing model for state agencies to analyze records from annual prescribed fire accomplishments; and (3) EPM, an interactive model that predicts fuel consumption and emissions from individual prescribed burns at time intervals, suitable for use with dispersion models. These software packages are important tools for planning and managing prescribed fires to meet site objectives and smoke management requirements.

The FERA Group is also measuring firefighters' exposure to smoke during prescribed burn operations in the coastal Oregon area and other areas within Oregon and Washington. This assessment will be used to develop a management strategy which will reduce the risk that firefighters will exceed smoke exposure limits.

Roger D. Ottmar,
Seattle Forestry Science Laboratory,
PNW Research Station,
Seattle, WA

BUFFER STRIP DYNAMICS IN THE WESTERN OREGON CASCADES

Although buffer strips have long been used as a protection tool when logging near streams, long-term studies investigating buffer strip dynamics are rare. During the late 1970s, Ivars Steinblums inventoried 40 buffer strips 1 to 15 years old in the western Oregon Cascades.

During the summer of 1990, 16 of the buffer strips were reinventoried to assess overstory changes. Sample areas ranged from 400 to 700 feet in length and 20 to 200 feet in width. Conifers >10 inches DBH were tallied by species and diameter. Conifer regeneration was sampled at 100-foot intervals (stream distance) across the width of the buffer strip.

Average combined conifer (western hemlock, western redcedar, and Douglas-fir) densities of these late successional buffer strips increased from 54 to 59 trees/acre since the earlier study; average combined conifer basal area decreased from 299 to 263 ft^2/ acre since the original study. Summarizing overstory dynamics of the sites:

1. Most buffers are making periodic, rather than episodic contributions of large woody debris.
2. Episodic blowdown from the January 1990 storms was restricted to two isolated locales.
3. Comparisons on many sites reveal a substantial increase in conifer density, particularly western hemlock, in the smaller size classes.

Conifer regeneration data suggest these buffer strips may be sufficiently stocked to maintain conifers over time. Variability was high, but average density of saplings ranged from nearly 200 to 3600 trees per acre. Regeneration was dominated by western hemlock, but western redcedar and Douglas-fir also contributed on many sites.

Kim Sherwood,
B.L.M., Wenatchee, WA
H.A. Froehlich,
OSU Forest Engineering Department

THE COASTAL REFORESTATION SYSTEMS STUDY: AN INTEGRATED COMPARISON OF ALTERNATIVES

The Siuslaw National Forest and the Pacific Northwest Research Station jointly initiated a large research and development effort to evaluate different combinations of reforestation techniques for use after clearcutting in coastal forests. In operational-size trials, factorial comparisons were made involving four site preparation methods, seven classes of stock of two species tubed or not tubed as protection from animals, and released or not released when vegetation was 3 years old. The 112 treatment combinations were applied as complete replications on six clearcuts located from north of Hebo to southeast of Florence. Seven-year results are available; second-decade effects are being determined as part of COPE research.

Site preparation improved subsequent tree survival and growth and reduced the level of competition from woody species for several years. Damage from animals, particularly mountain beavers (*Aplodontia rufa*), was high; so protection of trees with plastic mesh tubing improved survival — 84 vs. 53 percent. The effect of seedling protection was greater on unprepared than on prepared sites — 43 to 61 percent survival vs. 80 to 89 percent. Survival and growth of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) stock was in direct proportion to its initial size: the larger the stock, the greater its survival and total height. Survival and total height for the five classes of Douglas-fir stock were greater than for the two classes of western hemlock (*Tsuga heterophylla* (Raf.) Sarg.).

William I. Stein,
USDA Forest Service, PNW Research Station,
Corvallis, OR

THERAPEUTIC TREATMENT OF MATURE, LIVING DOUGLAS-FIR WITH CHLOROPICRIN, METHYLISOTHIOCYANATE, OR VORLEX REDUCES ROOT COLONIZATION BY THE PATHOGEN *PHELLINUS WEIRII*

In 1982, 135 Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) trees were segregated into three infection classes based on signs and symptoms of *Phellinus weirii* (Murr.) Gilb. infection. Eight fumigation treatments and one control treatment were applied to five replicate trees within each established class. Fumigant was applied to 3.3-cm-diameter holes drilled down (45° below horizontal) to the pith, in a helical pattern around the base of the tree. Measured volumes of fumigant were placed in the holes, which were then sealed with resin-coated wood dowels. Untreated trees were not drilled. Dose of fumigant for each tree was based on formulas relating the biomass of roots and lower bole to tree diameter. Stumps of trees killed before 1991 and stumps of all remaining live trees harvested in 1991 were excavated and their roots dissected and sampled for viable *P. weirii*. Twenty-four of the 30 trees treated with the two highest doses of chloropicrin were killed, presumably by the fumigant. None of the 45 trees treated with methylisothiocyanate (MITC) and only 3 of the 15 trees treated with Vorlex died (as did 3 of the 15 untreated controls). Volume of stained and decayed roots occupied by viable *P. weirii* was reduced 80 to 90 percent by MITC or Vorlex. This compares with reductions of 52 to 66 percent by chloropicrin at the two

lower, less phytotoxic doses and 9 percent for untreated controls.

This study demonstrates that fumigation can effectively reduce *P. weirii* infection in living Douglas-fir trees without adversely affecting the host tree.

Walter G. Thies and E.E. Nelson,
USDA Forest Service, PNW Research Station,
Corvallis, OR

SELECTED PANEL PRESENTATIONS

PANEL DISCUSSION - PERSPECTIVES AND DIRECTIONS FOR THE MANAGEMENT OF OREGON COAST RANGE FORESTS

The current and future direction of the management of our forest resources has become a highly provocative and contentious issue in recent years. To a large extent, it is the interplay of the scientific findings generated by the COPE Program and other researchers with the perspectives of private landholders, the managers of public lands, and the society at large that shape the future of forest policy. In attempt to frame a portion of the social climate in which forest policy decisions are made, we invited a group of panelists to discuss their perspectives on the management of Oregon Coast Range forests. A highly spirited discussion followed the presentations, and a diversity of viewpoints were presented. The presentations of two panelists, Jim Furnish, Forest Supervisor of the Siuslaw National Forest, and Barte Starker, Executive Vice President of Starker Forests, are provided.

PERSPECTIVES ON THE MANAGEMENT OF OREGON COAST RANGE FORESTS

I received a provocative and compelling book the other day, compliments of Chuck Willer of the Coast Range Association. Perhaps you've seen or heard of it. "CLEARCUT -The Tragedy of Industrial Forestry," published by Sierra Club. If you prefer looking backward instead of forward, the impact of the images and ideas in this book can only be described as deeply disturbing — as I'm sure the authors intended. The images have an emotional power, and the ideas an intellectual power, that speak to a wrongheaded legacy wrought on the land.

I have taken an excerpt from that book written by Chris Maser, a Corvallis author and consultant on sustainable forestry. "Nature designed a forest as an experiment in unpredictability; we are trying to design a regulated forest. Nature designed a forest over a landscape; we are trying to design a forest on each hectare. Nature designed a forest with diversity; we are trying to design a forest with simplistic uniformity. Nature designed a forest of interrelated processes; we are trying to design a forest based on isolated products. Nature designed a forest in which all elements are neutral; we are trying to design a forest in which we perceive some elements to be good and others bad. Nature designed a forest to be flexible, timeless continuum of species; we are trying to design a forest of long-term absolutes. Nature designed a forest to be self-sustaining and self-repairing; we are designing a forest to require increasing external subsidies — fertilizers, herbicides, and pesticides. Nature designed forests of the Pacific Northwest to live 500 to 1200 years; we are designing a forest that may live 100 years. Nature designed Pacific Northwest forests to be unique in the world, with twenty-five species of conifers, the longest lived and the largest of their genera anywhere; we are designing a forest that is largely a single-species on a short rotation. Everything we humans have been doing to the forest is an attempt to push nature to a higher sustained yield. We fail to recognize, however, that we must have a sustainable forest before we can have a sustainable yield (harvest). In other words, we cannot have a sustainable yield until we have a sustainable forest. We must have a sustainable forest to have a sustainable yield; we must have a sustainable yield to have a sustainable industry; we must have a sustainable industry to have a sustainable economy; we must have a sustainable economy to have a sustainable society."

As a Forest Supervisor of a forest of which he speaks, what have I got to say about this? Three things — "uncle," "thank you," and "please." Let me explain.

Where I grew up "Uncle" was a term to indicate submission. The glimpse we've all had of the President's Forest Plan for the Northwest I think provides ample evidence that management of federal lands is forever altered. The legal system has been used very effectively to bend our arm just about to the breaking point. It's my hope that the Forest Plan serves as an overt admission that old methods were not sustainable, that we can just say "Uncle," pick ourselves up off the ground, and get busy finding out if new ideas achieve what we're after.

Second, "Thank you," because if it were not for the dogged, unstinting efforts of the conservation community these past many years (far TOO many, I might add), we would not be at this threshold today. My deepest regret is that so much trust has been eroded in the struggle that it will be difficult to develop constructive and healthy working relationships for the future. Difficulty alone should not dissuade us from the task, however, because I believe healthy working relationships are imperative for future success.

Third, "Please," I say please because it's hard to turn a big ship on a dime. I don't want this to sound like whining, but I'm asking for a little indulgence in turning the Siuslaw National Forest in a new direction. Humility is in, smugness is out, and we'll be needing help and support from many sources — research, local government, conservation groups, and industry alike. After all, this is ultimately about managing spectacular and at-risk resources more than it is about the Forest Service. As long as we keep our eyes on the land, hopefully old fences will come down.

In summary, I would generalize by saying that the Forest Service has been accused of practicing industrial forestry on public lands, and found guilty, although we did it as well or better than anyone. But there is no right way to do the wrong thing. Now we need to develop a new art, that of ecosystem management.

I see federal lands in the Coast Range emerging with a short-term objective of refugia or reserves. Issues related to recovery of threatened and endangered species — owls, murrelets, and soon salmonids — are so pervasive and overwhelming as to dominate our management just as timber production did only a few years ago. I will not presume to guess what lies beyond the next few years, but it is my hope that federal lands can effectively fill a niche of providing significant large areas of late successional forest in the Coast Range. And that our management of these areas will make a telling difference in the recovery of those species dependent on such habitats. This is a responsibility I take seriously. For I fear that the appearance, structure, and function of federal and private forests are on a sharply divergent track. I believe that federal lands must shoulder the load if there is to be any meaningful future evidence in the Coast Range of the incredible magnificence of the coastal temperate rainforest.

Jim Furnish,
Supervisor, Siuslaw National Forest
Corvallis, OR

PRIVATE LANDOWNER PERSPECTIVES OF PAST AND FUTURE FOREST MANAGEMENT IN THE OREGON COAST RANGE

Introduction

I would like to begin with a background discussion of my perceptions of the beginning and the role of COPE. Next, I'll present some philosophical bullets that reflect my views and values. After all, the arguments and controversies concerning Coast Range management are really debates about values, very similar to discussions about religion. One person's religion can be a cult to another person. Much of what I say won't be new to you but you get to hear it again anyway. I'll conclude with a discussion about current and predicted future forest management strategies and activities.

COPE Background Discussion

— I was involved with developing COPE from the beginning.

COPE's original and continuing goal is to develop and promote reasonable, scientifically defensible management strategies and activities that will enhance the productivity and compatibility of commodity and non-commodity outputs from the Oregon Coast Range.

— Key principles underlying Starker Forests involvement in COPE:

1. Develop active management strategies; not hands-off passive approaches.
2. Promote compatibility of resource production, though not necessarily everything from every acre at all times.
3. Solve specific, identified problems or natural resource issues with a focus on riparian area management and reforestation techniques.
4. Stay practical.

As long as COPE remains true to those four principles I, and most other private forestland owners, will continue to support it financially and with time, research locations, and other cooperation.

Perspective is defined as the evaluation of important component parts from a particular view point or point in time; in other words a view of the whole from "somewhere." In my case that "somewhere" is as a forester with over 35 years of experience observing Coast Range forests; 22 as a working professional. "Somewhere" for me also means being the owner of a family-owned business and the father of 13-year-old twin girls. I intend to pass on a strong, resource rich company to my children which means a vital, healthy forest. It's why Starker Forests has such a long-term outlook and invests so heavily in forest management activities; especially reforestation.

In addition to being a forester and family business owner, I also bring the viewpoint of a private landowner and investor who has invested a lot of money in activities designed to meet present and future demand by people for affordable shelter and other commodities made of wood. Wood from logs has a high financial value precisely because it is so important to meet human needs for shelter and who among you wants to be shelterless? As an owner with private property rights, I have everything to lose vs. many that participate in the debate about forest use or non-use with nothing to lose; that is, no direct stake. That makes it very easy for them to demand it all; especially when motivated by religious fervor. From my point of view, there is no free lunch. Every regulation or restriction on management opportunities comes with a cost; either reduced productivity or increased direct costs of production. As a responsible landowner, I'm aware I have a social obligation to protect and provide for public resources and so I'm willing to bear added costs and forgo some productivity, but only when there is a legitimate need with a high probability of success. I am not willing to rely on the imagination and speculation of those with a different set of values than mine to set the rules of the game. That's where I see COPE as being useful; to establish likely cause-effect relationships and strategies with high probabilities of significant benefits. That's exactly what happened during the development of the new Oregon Forest Practice Act riparian rules. COPE research sites were visited and results from them were incorporated.

Lastly, believe it or not, I bring the perspective of an environmentalist; one who is concerned about the long-term health and vitality of the whole forest. As I said, I've spent

over 35 years in Coast Range forests with my father, Bruce, and grandfather, T.J., as mentors. You can't do that without developing an abiding respect for the land, the soil, the plants, and animals. Along with that respect comes a realization that man has always been, and always will be, a part of the picture. I challenge you to do a reality check. How are people to survive without using natural resources? I'm offended by those who advocate hands-off preservation of so-called natural reserves; for example, the current proposed Siuslaw National Forest plan where over 90 percent of the landbase may be off-limits to active management. What a terrible tragedy! I'm optimistic that reason will prevail someday.

Adaptive forest management has been on-going in the Oregon Coast Range for centuries; first, by native people who used fire, fished and hunted big game and seals and then, for the last 150 years, by non-native emigrants and their descendants who first tried farming and ranching and, later, tree farm management to supply wood for home construction. In addition to that management, there have been numerous, widespread natural disturbances such as windstorms, fires, insect outbreaks, landslides, and floods. The 1964 floods were not the first floods to cause coastal streams to sluice out and scour. The Tillamook Fire was not the first to burn hundreds of thousands of acres.

The Coast Range has been and will continue to be a dynamic, resilient, constantly changing landscape, in spite of some people's desire to freeze frame it like it is now by hands-off preservation. With 2.5 million people in Oregon and more coming, we are unwilling to allow fires and others natural disturbances to occur to make a leave-it-alone strategy work.

I want to remind you about the historical vegetative conditions of the Coast Range that I think are often forgotten. Precisely because of the constant natural and man-caused disturbances I've just mentioned, there was a tremendous diversity in forest age-class distributions. It was by no means wall to wall mature forests when settlers arrived in the mid-1800s as is so often portrayed by activists and the media. I call your attention to work by forest historian Bob Zybach and BLM cartographers that show vast areas of younger forest existing in the 1800s.

The Coast Range is not going to hell in a hand basket. There has been almost 100 years of active forest management including harvesting; most of it quite severe and heavy handed compared to today's standard practices. Practices today are not the same as 50 or even 20 years ago, but preservation activists and the media continue to promote that myth. In spite of such a long period of intensive harvesting and other management activities, there is tremendous forest diversity and productivity in the Oregon Coast Range. This is due to the wide variety of owners who have different objectives and timeframes and to the vast resiliency of Coast Range systems — far more resiliency than most other forest types in the U.S. and throughout the world. When I view the Coast Range from a landscape perspective, that is from very high over a long timeframe, I see tremendous diversity now and forever more in spite of anything people do or, maybe, because of everything people do.

One of the most visible manifestations of on-going adaptive forest management is the changes continually evolving in the Oregon Forest Practices Act, especially in the past 10 years. It's frustrating to me that there is never any acknowledgement of that, only a demand to ratchet another set of restrictions ever tighter. There is clearly an unwillingness, or perhaps a conscious strategy, to not wait long enough for effects of rules to become apparent before the next set are demanded. As an investor representative, I can tell you this trend, and the uncertainty and instability it promotes, is making everyone who invests in forestry in Oregon have second thoughts. While that might bring smiles to the faces of some, ultimately it would be very bad for Oregon and its citizens along with wood product consumers worldwide.

I should make it clear that I do support most and comply with all the changes to the rules that have occurred in the past. I am very familiar with the current process changing the rules affecting management in and near riparian areas. I served as the Board of Forestry's representative to a committee that drafted the rules during the past 12 months. After many months of education, discussion and compromises, I am comfortable with the regulation package that was developed and is currently being reviewed. I think the proposed rules are workable and will adequately protect all the natural resources of concern. We have the opportunity now, with the innovative and forward-looking approach that the soon-to-be-adopted stream rules take, to use the new rules to improve streams and riparian habitat. The new stream rules are goal-oriented and will maintain streams that are in good condition and at the same time allow areas to be improved through active management and associated incentives. We need to move away from more regulation towards, instead, a goal-oriented system of education and incentives just as these new riparian rules do. They should serve as a model. I will continue to lobby for such a shift.

At this point, I would like to switch to a discussion about specific forest management activities and strategies I see for the future. The underlying principles of these management strategies are compatibility of resource benefits and resiliency to disturbance. The Coast Range is some of the most productive land in the world and grows Douglas-fir which is the best structural material in the world.

1. Less and less burning. But still aggressive reforestation efforts. Passive reforestation is ineffective and doomed to fail in the Coast Range. Simply naive wishful thinking to believe otherwise. Native stands are a result of drastic disturbances.

2. Progressive genetic improvement of tree form and growth rates maintains diversity.

3. Fertilization for improved tree growth rates (especially juvenile stands).

4. Commercial thinning for profit and to manipulate stand structure and tree size and species composition.

5. Harvesting with processors and cable systems. Made possible because increased timber value has made more tools and techniques practical and affordable.

6. Unit size variability with more leave trees.

7. Less road construction because most of roading is done now.

8. Road maintenance. Culverts, seeding, running surface, drainage.

9. More temporary road closures, though not abandonment or removal.

10. Fish passage improvement by relaying culverts and replacing some culverts with bridges.

11. Establishing conifer reproduction in riparian areas; probably through aggressive vegetation manipulation including logging and site preparation and planting of cedar and or hemlock.

12. Fresh water fish habitat improvement projects, though it's a cruel hoax to portray those activities as a panacea to fish population problems as is often done by the media.

Epilogue

Starker Forests has been in business since 1936 — almost 60 years. We have been successful because we care about the land and what lives on it. We will continue as good stewards of our forests and will use COPE's help to do that.

COPE and other research organizations will continue to play an important role in our understanding of our forests.

The most important ingredients in a good forest management strategy are experience and common sense — we're optimistic that will eventually prevail.

Barte B. Starker,
Executive Vice-President,
Starker Forests, Inc.,
Philomath, OR

SELECTED FIELD TOUR ABSTRACTS

FIELD TOUR OVERVIEW

On March 31, 70 participants joined a host of 13 researchers in a caravan of vans to visit five sites in the Coast Range. Doug Bateman oversaw logistics for the trip, and Bill Emmingham led the program. The researchers covered a broad array of topics at the various sites, including the importance of in-stream structures for salmonids, riparian zone silviculture, wildlife habitat relationships in riparian areas, landscape structure and management, and the ecology of broadleafed shrubs. We have selected the abstracts from three of the field presentations for inclusion in this issue of the <u>COPE Report</u>.

DYNAMICS OF ALDER-DOMINATED RIPARIAN ZONES

There have been two studies of succession in Coast Range alder stands, one in riparian areas, and one on hill slopes. Both reached similar conclusions. First, as the tree canopy aged, the height and cover of the shrub layer increased. Second, tree regeneration in these aging alder stands was very rare and, where found, tended to occur on woody debris.

Riparian management practices of the last couple of decades have focused on creating buffer strips along streams, narrow strips of intact forest adjacent to clearcuts. These strips are left to provide short-term stream cover and protection from erosion; they are also left to provide a long-term source of shade and large woody debris. Because many of these buffer strips in the Coast Range are alder-dominated, concerns have been raised about their real long-term value. Specifically, would the environmental changes associated with an area becoming a buffer strip hasten the senescence of the overstory, increase the vigor of the understory shrubs, and further reduce conifer regeneration?

We have done a chronosequence study of alder-dominated buffer strips in an attempt to address these concerns. We sampled 44 Coast Range buffer strips which ranged in age from 0 to 33 years since adjacent cutting.

Our results surprised us. We did find that there was an increase in shrub cover when buffer strips were compared to riparian communities with the adjacent forest intact, but there was no increase in shrub cover over the 33 years of the chronosequence. We had expected to see shrub cover continue to increase in response to the increased sun light. It may be that, in 33 years, the adjacent forest regrows sufficiently to eliminate this light. We also found no evidence of increased rate of senescence of the alder overstory. We did find, as the succession studies have, that shrub cover increases with overstory age, and that the limited conifer regeneration is found primarily on woody debris.

Our conclusion is that alder-dominated buffer strips are quite biologically stable. There is some increase in shrub cover associated with creating a buffer strip; the real concern is that associated with any alder-dominated riparian community: the long-term supply of conifers.

We are beginning two new studies. The first will be documenting the distribution and size of different riparian communities in riparian areas relatively undisturbed by humans. The second looks at the finer scale of both the horizontal and vertical structural pattern of vegetation in riparian plant communities.

David Hibbs,
OSU Forest Science Department

RIPARIAN VALUES FOR BIRD COMMUNITIES IN THE OREGON COAST RANGE

Riparian areas generally support a greater number of vertebrate species and greater abundances of many species than adjacent uplands. In Oregon and Washington, this "riparian influence" supposedly is the result of juxtaposition of water, cover, and food in most riparian areas; a greater diversity of plant composition and structure in riparian areas than adjacent uplands; higher edge-to-area ratios in riparian areas because their elongated shape maximizes edge effects; and more favorable microclimates in riparian areas than surrounding uplands because of increased humidity, higher rates of transpiration, and greater air movement. These conceptual values of riparian areas have stemmed largely from studies in relatively arid environments where transriparian gradients in microclimate and vegetation are pronounced. In addition, much of our understanding of riparian-wildlife relationships is based on riparian areas associated with large streams and rivers where the riparian influence is relatively pronounced. It is unclear whether these relationships extend to mesic environments of the westside forests or to the smaller mountain streams; yet, small perennial or intermittent mountain streams constitute the majority (83 percent) of total stream mileage in the Pacific Northwest.

The strength and durability of the current riparian-wildlife conceptual model has inhibited researchers and land managers from questioning its applicability in specific environmental settings and has led land managers and others to believe that riparian areas universally support more species and numbers of vertebrates than uplands. Our results suggest that this assumption may not be true for diurnal birds along second- and third-order streams in mature forests, and riparian management alone may not meet the needs of the breeding avifauna of mature forest stands of the central Oregon Coast Range; a landscape-level approach that considers upslope habitat and riparian habitat in conjunction may be more effective.

Recently, it has been suggested that streamside areas function as natural migration routes and travel corridors for the movement and dispersal of animals among suitable habitat patches. Unfortunately, there is virtually no empirical data to support or refute this hypothesis, particularly in the Pacific Northwest. Until more is learned about habitat connectivity and dispersal, a coordinated network of upslope and streamside mature forest corridors to connect mature forest patches with permeable intervening stands may be the most effective overall strategy.

Kevin McGarigal and William C. McComb,
OSU Forest Science Department

WATER TABLES, FLOODING, AND RIPARIAN TREES

Riparian areas often have shallow water tables, and they sometimes are flooded. Therefore, the trees growing in those riparian areas often must be able to tolerate waterlogged soils, and they sometimes have to endure partial immersion. Tolerance of excess moisture differs among Northwestern tree species, however, and the amount of that excess moisture differs among riparian areas. Optimal riparian silviculture should involve the estimation of moisture conditions at any given site and the selection of species best able to survive and grow under those conditions.

The density and petiole length of skunk-cabbage and the presence of slough sedge were used as indicators of winter water table depths in a Coast Range study completed 25 years ago (Minore 1969). Total skunk-cabbage petiole length per meter of line intercept was correlated with average winter water table depth where winter water tables were below the soil surface. Slough sedge was present with the skunk cabbage where winter water tables were above the soil surface.

The skunk-cabbage correlations were used in riparian areas and swamps on the Olympic Peninsula to relate the occurrence and radial growth of red alder, western redcedar, Sitka spruce, and western hemlock trees to average water table depths (Minore and Smith 1971). All four species tolerated winter water tables deeper than 15 cm. Red alder and western redcedar also grew well when stagnant water was less than 15 cm below the soil surface, as did alder and Sitka spruce when the water was flowing. Western hemlock seemed intolerant of water tables less than 15 cm deep. Douglas-fir was absent on wet areas even though abundant Douglas-fir seed sources were present nearby.

Lodgepole pine, western redcedar, red alder, and Sitka spruce were most tolerant of shallow water tables when seedlings of eight Northwestern trees species were grown over artificial water table depths of 7.5, 35.5, and 66.0 cm in a controlled experiment (Minore 1970). Douglas-fir was the least-tolerant species tested.

Douglas-fir also was the least tolerant of six Northwestern tree species subjected to artificial flooding (Minore 1968). Western redcedar and lodgepole pine were most flood-tolerant. Red alder, Sitka spruce, and western hemlock showed intermediate flood tolerance. All six species were damaged more by flooding in the summer than they were by flooding during the winter dormant season.

Recommended Readings

Minore, D. 1968. Effects of artificial flooding on seedling survival and growth of six Northwestern tree species. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon. Research Note PNW-92. 12 p.

Minore, D. 1969. Yellow skunk-cabbage (*Lysichitum americanum* Hult and St. John) — an indicator of water-table depth. Ecology 50(4):737-739.

Minore, D. 1970. Seedling growth of eight Northwestern tree species over three water tables. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon. Research Note PNW-115. 8 p.

Minore, D., and C.E. Smith. 1971. Occurrence and growth of four Northwestern tree species over shallow water tables. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon. Research Note PNW-160. 9 p.

Don Minore,
USDA Forest Service, PNW Research Station,
Corvallis, OR

ERRATUM

The booklet for the symposium included speaker abstracts and poster abstracts. Credit for the poster "Active Riparian Area Management: Effects on Forest Resources" unintentionally contained incorrect names. The authors were: Arne Skaugset, Elizabeth Dent, Doug Bateman, Mike Newton, Jenny Walsh, Elizabeth, Cole, Loren Kellogg, Stephen J. Pilkerton, Mark Miller, and Ben Stringham. We sincerely apologize for the error.

The booklet omitted one poster abstract: "Use of Invasive Treatments to Control Laminated Root Rot in Living Douglas-fir: Effects on Tree Growth and Survival" by Connie Harrington and Walter G. Thies. We've included that poster abstract in this current *COPE Report* and apologize for the unintentional omission.

COPE

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COPE Report

Coastal Oregon Productivity Enhancement Program

Promoting Integrated Management of Oregon's Coast Range Forests Through Research and Education

Volume 7, Number 4

October 1994

From the Program Manager

Throughout the Oregon Coast Range there are thousands of acres of intermediate sized, second-growth stands of Douglas-fir and other species. From a silvicultural perspective, many of these stands are in immediate need of commercial thinning or will need to be thinned in the not too distant future. This presents us with an opportunity to develop integrated silvicultural and wildlife habitat prescriptions that could potentially have long-term benefits for both timber and wildlife resources. The basic question is, how can we conduct commercial thinning operations to increase the future market value of the residual stand while simultaneously enhancing wildlife habitat? Clearly, there are many unknowns associated with this fundamental question. For example, how will residual overstory trees, underplanted conifers, and understory vegetation respond over time to various thinning intensities and how will this affect habitat suitability for different wildlife species? These and other questions are the focus of two comprehensive COPE studies, one of which has been underway since 1991 and is updated for you in this issue of the COPE Report.

In coming issues of the COPE Report, a second and more ambitious study of commercial thinning and wildlife will be described for you in detail. This study is a cooperative effort between the Oregon Department of Forestry, Stimson Lumber Company, and the COPE Program. It is located on the Tillamook State Forest and nearby lands owned by Stimson. I recently spent several weeks on these study sites helping to collect baseline stand and wildlife data prior to thinning. The diversity I observed in these stands was unexpected and reinforced my belief that there is potential to actively manage second-growth forests to enhance both timber and wildlife resources. Given this hypothesis and the fact that second-growth, intermediate-sized stands have received relatively little attention regarding wildlife, the work that COPE scientists are doing may open new doors of opportunity for managers.

Steve Hobbs

IN THIS ISSUE

COPE Report

This issue of the *COPE Report* was prepared by Doug Bateman, Gretchen Bracher, Pat Connolly, Liz Dent, Bill Emmingham, Skye Etessami, John Hayes, Kathleen Maas, Arne Skaugset, and Judy Starnes. The *COPE Report* is produced quarterly as a contribution of Adaptive COPE. Because of space limitations, articles appear as extended abstracts. Results and conclusions may be based on preliminary data or analysis. Readers interested in learning more about a study should contact the principal investigator or wait for formal publication of more complete results. Comments and suggestions concerning the content of the *COPE Report* are welcomed and encouraged. To receive this free newsletter, or for information about Adaptive COPE, contact Adaptive COPE, 2030 S. Marine Science Dr., Newport, OR 97365, (503) 867-0220. For specifics on the overall COPE Program, contact Steve Hobbs, COPE Program Manager, Forestry Sciences Laboratory, 3200 SW Jefferson Way, Corvallis, OR 97331, (503) 750-7426.

The COPE Program is a cooperative effort between Oregon State University's College of Forestry, the USDA Forest Service, Pacific Northwest Research Station, the USDI Bureau of Land Management, other federal and state agencies, forest industry, county governments, the city of Newport, and the Oregon Small Woodland Association. The intent of the program is to provide resource managers and the public with information relative to the issues and opportunities associated with the management of fish, timber, water, wildlife, and other resources of the Oregon Coast Range. The COPE Program emphasizes an integrated approach—an integration of research and education and an integration of scientific disciplines—to find effective ways to manage these diverse resources collectively.

The COPE Program has two related components: Fundamental COPE and Adaptive COPE. Comprised of OSU and PNW scientists based primarily in Corvallis, Fundamental COPE addresses problems related to riparian zone management and reforestation in the Coast Range through basic research. Adaptive COPE is comprised of an interdisciplinary team responsible for applying and adapting new and existing research information to solve specific management problems. Stationed on the coast in Newport at the Hatfield Marine Science Center, the Adaptive COPE team is also responsible for providing continuing education opportunities to facilitate technology transfer.

ADAPTIVE COPE

INSIDE ADAPTIVE COPE

Gabe Tucker recently left the COPE program to pursue other interests in the College of Forestry. Gabe will be working on studies that examine young stand silvicultural treatments and their effects on stand yield, wood quality, and wildlife habitat. Bill Emmingham has moved into the slot of silviculturist with the Adaptive COPE program. Bill will be continuing Adaptive COPE's strong research and technology transfer program in silviculture, and will add the strength of his many years in the field to the program.

Eric Horvath left the program in June. Eric was an integral part of the program since he first began working as a research assistant with Adaptive COPE in 1989, and made his mark on the many wildlife, silviculture, and hydrology studies in which he was involved. Eric is now pursuing his research interests in ornithology, leading natural history tours, and managing his rental properties.

Nobuya Suzuki began work on his Ph.D. in September with funding from the Adaptive COPE program. Nobuya will be examining changes in small mammal and amphibian populations and wildlife habitat changes in young stands that have been commercially thinned. John Hayes, Wildlife Ecologist for the Adaptive COPE program, will be serving as Nobuya's academic advisor. Nobuya's Master's work examined small mammal and amphibian populations in beaver pond habitat of the Coast Range and was funded by the Fundamental COPE program under the direction of Dr. Bill McComb.

Liz Dent began working full time for Adaptive COPE as a research assistant in September. Liz received a B.S. in Geography from Humboldt State University and a Master's degree in Forest Hydrology with a minor in Water Resources at OSU in 1993. Her thesis work examined channel morphology as influenced by the interactions between hillslope and instream processes. She worked for the U. S. Forest Service for several years in California. Liz brings a strong background in hydrology and forestry to the program.

Adaptive COPE hired Mike Adam as a research assistant in March. Mike brings a strong background in wildlife, ecology, and forestry to the program. He received his B.S. in Wildlife Biology at the University of Wisconsin in 1990 and his M.S. in Forestry from the University of Kentucky in 1992. Mike has worked extensively with bird, mammal, and amphibian populations and has published several works on bats and amphibians. He will be responsible for coordinating much of the work on a new COPE study examining commercial thinning on the Tillamook State Forest and adjacent Stimson forest lands this summer, and will move into a central position in many of the COPE projects within the next year.

This summer the Adaptive COPE team hired Jennifer Weeks and Vanessa Stone to assist on research projects. Jennifer was brought on to work on bird inventories for the commercial thinning study in Tillamook. Jennifer has a B.S. in Wildlife Science from Humboldt State University in Arcata, California. She will continue work on bird populations in thinned and unthinned stands for the next 2 years while pursuing a master's degree at Oregon State University in the Department of Forest Science under the direction of John Hayes. Vanessa is an undergraduate in Forest Engineering at Oregon State University. Vanessa is assisting with the hydrology and fisheries research program.

THE EFFECT OF WOODY DEBRIS PIECE SIZE AND ORIENTATION ON AQUATIC HABITAT IN OREGON COAST RANGE HEADWATER STREAMS

Understanding of the role of large woody debris (LWD) in the structure and function of forested headwater streams has increased markedly over the past several decades. In recent years, COPE researchers have investigated and reported on LWD loading in coastal streams in various ownerships and management conditions, the relationship between riparian area management and LWD loading, and the relationship between LWD complexity and fish populations. These studies of the relationship between forest land management (especially riparian area management), LWD in streams, aquatic habitat, and fish populations continue to augment our understanding of the role that wood plays in the ecology of forested headwater streams. However, gaps remain in our knowledge of the effects of LWD on aquatic habitat, especially regarding the number, orientation, and size of woody debris pieces required to maintain healthy populations of aquatic organisms.

This lack of knowledge is particularly acute for small, forested, coastal headwater streams draining harvest-regenerated, young-growth stands. These stands typically have hardwood-dominated riparian areas and the streams draining these stands can be debris poor. There is continuing debate regarding how to establish and maintain an appropriate number and size of conifers in streamside areas to function as potential future sources of LWD. Over the long term, riparian areas will be managed so that riparian stands will contribute the size and amount of LWD needed to provide structural heterogeneity and habitat diversity to streams. However, in the short term, some streams will require active intervention to achieve effective LWD loading. To intervene intelligently requires knowledge of the relationship between the size and number of LWD and the formation of aquatic habitat.

This project is intended to help provide information that will allow enlightened intervention in LWD placement in streams. The objective of the project is to investigate the influence of size and orientation of LWD pieces on the quantity and quality of aquatic habitat. We experimentally manipulated streams by placing different sized pieces of LWD into riffle-dominated sections of debris-poor streams. We hypothesized that the size of the scour pools created by the LWD would be a function of the size and orientation of the debris pieces. We used the presence of fish in the scour pools as an indication of habitat quality. Preliminary results and a description of the project were presented in a previous *COPE Report* article (see Recommended Reading).

Methods

In this paper, we report results of the first 5 years of the study. LWD pieces were placed into two headwater streams: J-Line Creek, on the Salem district of the Bureau of Land Management, and Preacher Creek, on the Alsea District of the Siuslaw National Forest. Both streams are second order, high gradient, anadromous fish-bearing tributaries to Lobster Creek, a designated COPE study basin. Prior to treatment, the area adjacent to the experimental reaches of both streams had been logged, and the riparian areas were dominated by red alder and salmonberry. The streams had few pools, limited LWD, and were largely riffle-dominated.

Eighteen LWD pieces were placed into each stream. The treatments consisted of three debris piece sizes and two orientations. The woody debris piece sizes were 8, 16, or 24 inches in diameter at the piece midpoint. The pieces were oriented either as "ramps" or "spanners." A ramp was placed in the stream with one end of the log resting on the bank and the other end oriented roughly 45 degrees downstream. A spanner was placed in the stream perpendicular to flow and flush with the stream bottom. We used a hydraulic excavator to place the debris pieces and to key the spanners into one or both streambanks so the piece rested on the stream bottom. All woody debris pieces were bucked and limbed, young Douglas-fir. All LWD pieces were at least 23 feet long and were roughly two and a half times longer than the active channel width. None of the debris pieces were secured in any way, allowing movement in response to changes in streamflow.

We inventoried fish habitat, conducted an open traverse of the streambed and banks, and censused fish populations. We collected pretreatment data at the two streams during the summer of 1989 prior to debris placement. Fish habitat inventories and fish population census were completed each summer through 1993. The fish habitat inventory consisted of identifying habitat units, specifically glides, pools, and riffles, within the experimental reaches. The length of each habitat unit was measured and the average width and depth estimated. Because this measurement method is stage-dependent, the fish habitat inventories were carried out during summer low flows when year-to-year variation in flow is minimized.

Open traverses of the streambed and banks were completed during the summers of 1990, 1991, and 1993. We used a total station electronic theodolite for open traverses. We collected sufficient data along the bed of the stream and the streambanks to allow construction of a high resolution

map. We located LWD pieces that were placed in the streams as well as those naturally occurring in the traverses. We compared these maps with subsequent versions to track changes in stream morphology caused by the LWD pieces and movement of LWD.

Census of the fish populations were conducted by using electroshocking. A pass removal-depletion method was used to census age 0+ trout (young-of-year cutthroat trout and steelhead trout), age 1+ cutthroat trout, juvenile steelhead trout, and juvenile coho salmon. Fish were sampled in all pools, all units treated with a debris piece, and half of the riffles and glides. Fish sampling was conducted during the summer of each year coincident with the fish habitat inventory.

We compared topographic maps constructed from the open traverses to quantify the effect of LWD on local scour and pool development. We quantified and compared residual pool volume of the experimental stream reaches to determine the effect of the LWD pieces on local scour. Residual pools are pools that retain water at the cessation of surface flow in the stream; residual pool volume is the volume of water retained in the residual pools when surface stream flow ceases. We identified residual pools on the constructed topographic maps of the streams by concentric, closed topographic contours indicating depression of at least 15 cm. We determined residual pool volume for J-Line Creek and Preacher Creek in 1989, before debris placement, and in 1993, four years after debris placement.

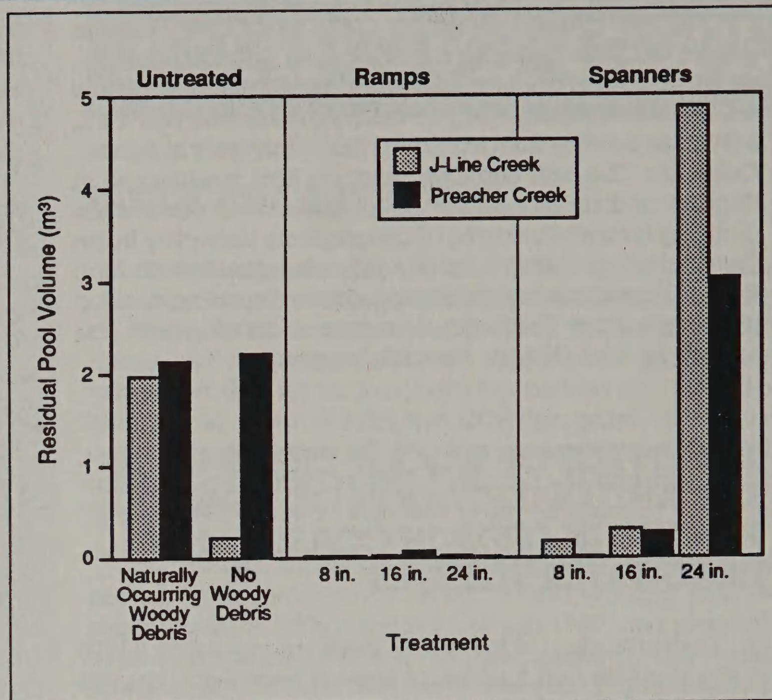

Figure 1. 1993 residual pool volume in untreated and treated sections of J-Line Creek and Preacher Creek.

Results

Physical Habitat

The pieces of large woody debris added to J-Line Creek and Preacher Creek affected the form of the streambed and banks. Of particular interest is the effect that woody debris had on local scour and pool development around the debris pieces. Total residual pool volume in experimental reaches increased 679 percent in J-Line Creek and 304 percent in Preacher Creek between 1989 and 1993. In J-Line Creek, the total residual pool volume went from 1.1 m^3 in 1989 to 7.7 m^3 in 1993. In Preacher Creek, the increase was from 2.5 m^3 in 1989 to 7.9 m^3 in 1993. Not all of the increase in residual pool volume was the direct consequence of the treatments. A portion of the residual pool volume is associated with naturally occurring LWD and with non-debris structures such as boulders or lateral scour adjacent to stream banks (Figure 1). The residual pool volume not associated with the treatments accounted for 4.4 m^3 or 57 percent of the total in Preacher Creek, and 2.2 m^3 or 29 percent of the total in J-Line Creek. Thus, LWD added to the streams accounts for 43 percent of residual pool volume in Preacher Creek and 71 percent in J-Line Creek.

Of the residual pool volume attributed to the treatment debris pieces, by far the most effective treatment for local scour was the large spanner. For J-Line Creek, 90 percent of residual pool volume resulting from LWD installation was associated with the 24 inch spanners. In Preacher Creek, 84 percent of residual pool volume was associated with 24 inch spanners. Smaller spanners and ramps of any size had minimal influence or residual pool volume.

Fish

Analyses of population densities of juvenile coho and steelhead and young-of-year trout are not presented at this time because extreme year-to-year variation has obscured distinct responses to treatments. Perhaps a clearer trend in populations will develop and allow more extensive analyses of these data by the end of the project. To date, interactions among these populations and mortality associated with migration and ocean conditions appear to have overwhelmed any effect of the treatments. In contrast, age 1+ cutthroat trout population densities were far less variable (Figure 2). The reduced variability may be due to their greater degree of residency in freshwater streams. All further analyses for this report were limited to age 1+ cutthroat trout.

The treatments showed a clear effect on density of cutthroat trout (Figure 3). Densities of cutthroat trout exhibited a consistent response throughout the post treatment period from 1990 to 1993. Densities of cutthroat trout may be divided into two distinct groups. The 16" and 24" spanners have densities of age 1+ cutthroat trout similar to the naturally occurring pools, while the other four treatments have

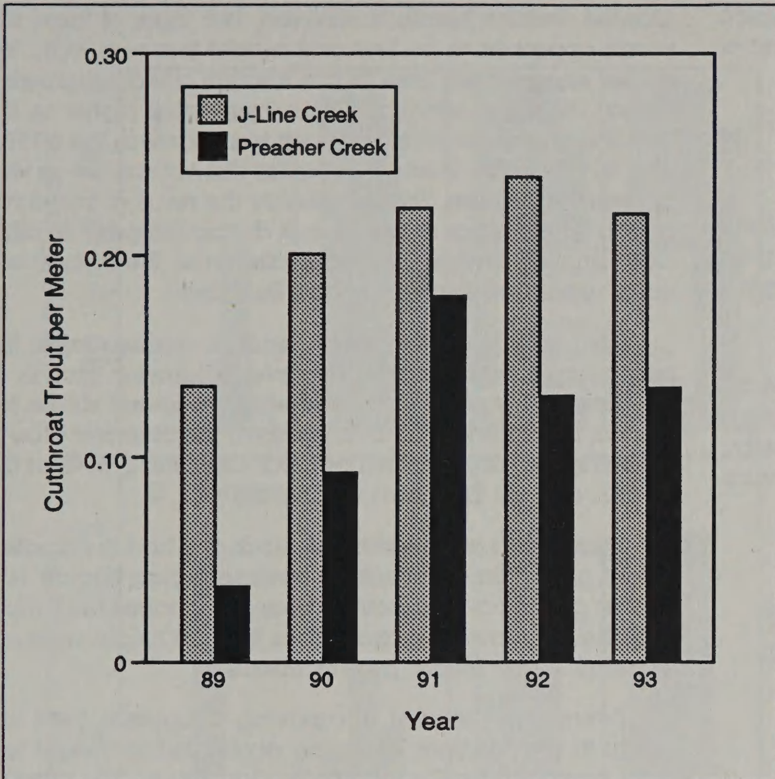

Figure 2. Density of cutthroat trout in J-Line Creek and Preacher Creek from 1989 to 1993.

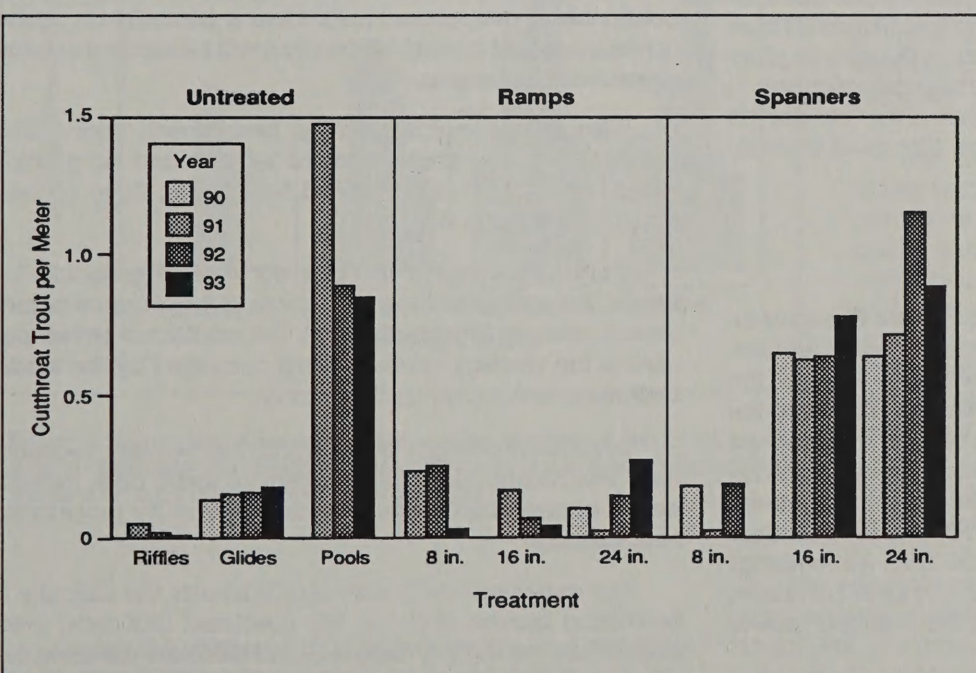

Figure 3. Combined densities of cutthroat trout in untreated and treated sections of J-Line Creek and Preacher Creek.

densities of age 1+ cutthroat trout similar to the riffle and glide habitats. The concentrations of age 1+ cutthroat trout coincide well with the location of residual pools which were principally associated with the large spanners, especially the 24-inch spanners.

The observed densities of age 1+ cutthroat trout is consistent with a perceived relationship between habitat created by the treatment LWD and habitat use. Apparently, residual pools created by local scour around the large spanners during the first winter after the LWD pieces were installed have been, more or less, maintained ever since. The age 1+ cutthroat trout have responded to the increased pool habitat by moving into it and have continued to use it at least during summer low flows.

Summary and Conclusions

This project was initiated to investigate the relationship between LWD piece size and orientation on both the quantity and quality of aquatic habitat. We hypothesized that LWD pieces would create local scour and cause pools to develop around the debris pieces and the size of the pool would be proportional to the size of the log. Some LWD pieces have created local scour and caused scour pools to develop. Pool development has been limited to 16- or 24-inch spanners and is virtually absent from the remainder of the treatments. The pools that have been created by the LWD pieces appear to provide habitat for cutthroat trout. These trout are using the pools created by the treatments at similar densities as those using naturally occurring pools.

The data analysis for this project, to date, deals only with the creation and use of summer low flow habitat. However, the results clearly show that if the objective is to affect local scour and develop pools for summer habitat in cobble-bedded, sandstone, headwater streams in the central Oregon Coast Range, then, of the treatments tested, an effective way to accomplish this is to install large logs perpendicular to the stream flow and flush with the stream bottom.

It should be noted that this project was not intended to be an enhancement project and should not be considered a reach level investigation into aquatic habitat restoration. It is individual habitat

unit level research that investigates the effect of different sizes and orientations of LWD have on both the amount of habitat formed and fish use of that habitat.

Recommended Reading

Skaugset, A., J. Schroeder, and R. Rhew. 1991. The influence of large woody debris piece size and orientation on function in small streams: first year results. COPE Report 4(2):4-6.

Arne Skaugset, Liz Dent, and Doug Bateman,
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FIRST-YEAR PERFORMANCE OF FIVE CONIFER SPECIES UNDERPLANTED IN COMMERCIALLY THINNED DOUGLAS-FIR STANDS

Introduction

On federal forest land in the Oregon Coast Range, tens of thousands of acres of Douglas-fir plantations are approaching commercial thinning age. Under Option 9 of FEMAT, these forests can only be commercially thinned when it enhances habitat for spotted owls. An Adaptive COPE interagency study was initiated on the Siuslaw National Forest to address the feasibility of manipulating Douglas-fir plantations through commercial thinning and underplanting to create multi-storied stands and to encourage old-growth characteristics at a younger stand age. (For more information see Recommended Readings).

Methods

As part of the study, five conifer species (Douglas-fir, grand fir, Sitka spruce, western hemlock, and western redcedar) were planted during the winter of 1993 at the Cataract study site on the Mapleton Ranger District of the Siuslaw National Forest. Fifty-two trees of each species were planted at 4 X 4 foot spacing in each of four thinning densities. The four overstory tree densities were an unthinned control plot with 224 trees per acre (TPA), and plots thinned to densities of 100 TPA, 60 TPA, and 30 TPA. All seedlings were protected from browse with Vexar tubing. In this article, we provide a summary of the first-year survival and growth of the planted seedlings.

Results and Discussion

All Douglas-fir, grand fir, and western redcedar died in the unthinned (control) treatment (Figure 1A). Only one Sitka spruce survived the first year. Fifty-two percent of the planted western hemlock survived, but vigor of these survivors appeared to be low and needle loss was high. We do not expect these trees to live through a second growing season. Seedling survival was substantially higher in the 100 TPA treatment and continued to improve in the 60 TPA and 30 TPA plots. Western redcedar did not survive as well as the other species. This is probably the result of frost damage to the seedlings that occurred during shipping. In other COPE studies, western redcedar often had the highest survival rates. (See Recommended Readings).

Sitka spruce and western hemlock demonstrated the best overall performance. However, diameter growth of Douglas-fir, the planted species with the lowest shade tolerance, is only 0.1 to 0.7 mm less than the diameter growth of Sitka spruce and western hemlock diameter growth in the 60 TPA and 30 TPA plots (Figure 1B).

Sitka spruce and western hemlock also had the greatest height growth in all overstory treatment plots (Figure 1C). Sixteen percent of all surviving trees experienced height loss over the first growing season. Trees that lost height were not included in the height growth means.

Twenty-one percent of surviving Douglas-fir trees lost height in the first year. Browsing accounted for height loss in 59 percent of the Douglas-fir that lost height. The remainder of the Douglas-fir that lost height experienced death of the terminal branch or cage injury. Cage injury resulted from the leader growing into the Vexar tube causing crooked growth.

Twenty-one percent of surviving grand fir experienced height loss. This apparent height loss is primarily an artifact of measurement inconsistencies that will be rectified in future measurement periods.

Sitka spruce maintained the best growth form during the first year, i.e. single, straight leaders and no multiple stems. Only four trees exhibited height loss; three of these experienced cage damage.

Thirteen percent of the planted western hemlocks lost height, primarily resulting from death of the terminal branch (also known as leader dieback). An additional seven percent of the western hemlock were damaged by the leader becoming entangled in the tubing.

Seventeen percent of the surviving western redcedar trees lost height. Eighty-six percent of these trees that lost height experienced leader dieback caused by preplanting frost damage.

Our experience with damage illustrates the difficulty in predicting browse severity. We predicted that most seedlings would be heavily browsed and therefore we protected all test seedlings. However, browsing by elk and deer was negligible for all species during the first year. A large number of trees in the 30 TPA plot went unbrowsed despite having had the Vexar tubes removed by elk. If browse levels remain low, the Vexar tubing may prove to be more a liability than an asset by hindering leader growth and causing cage damage.

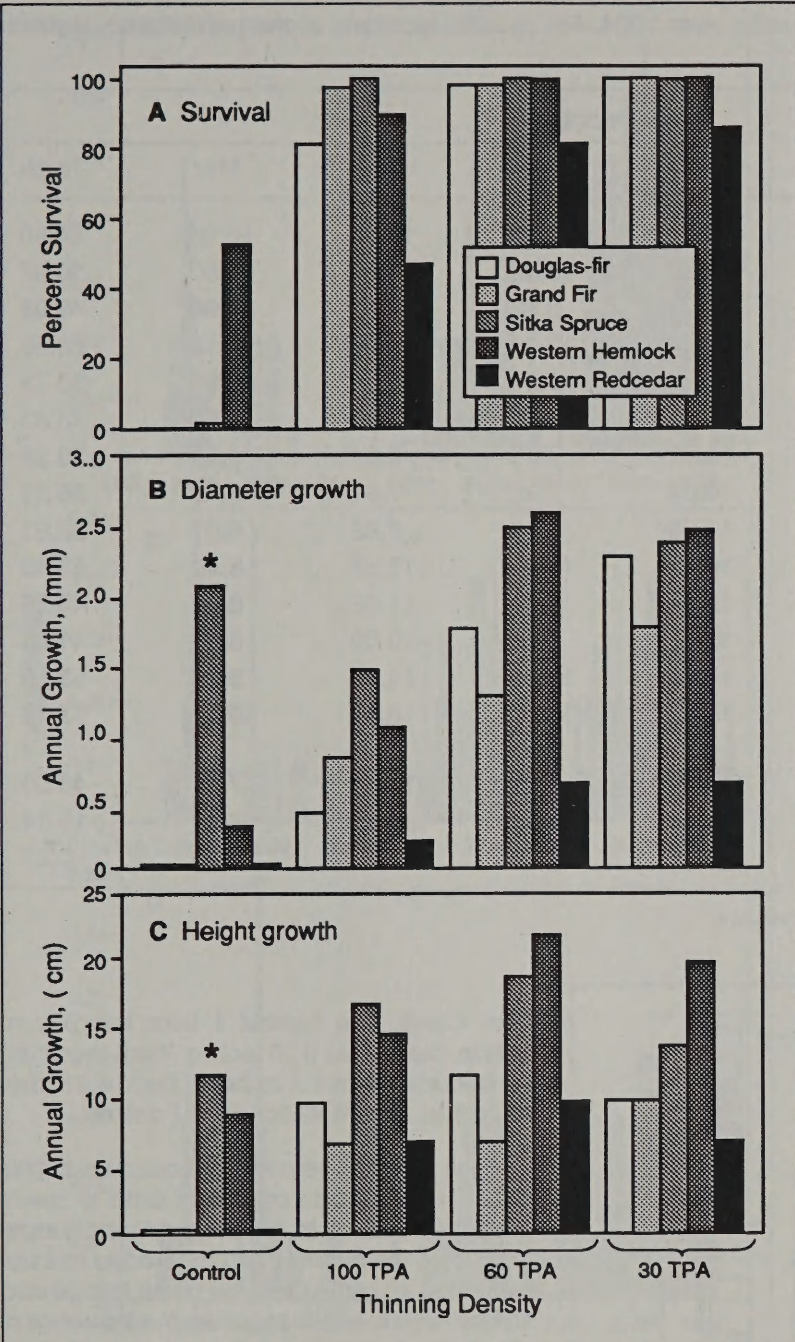

*Figure 1. Response of underplanted conifer species in the first growing season. *Diameter and height growth of Sitka spruce in the unthinned stand is based on only a single surviving seedling.*

During the winter of 1994 bigleaf maple and red alder were also planted in separate trials. All hardwood and conifer species were planted on the Wildcat Creek (Hebo Ranger District) and Keller Creek (Waldport Ranger District) replication which were installed during the winter of 1994. Monitoring of the seedlings will occur after the first, second and fourth growing seasons. The results of this work will appear in a future issue of the COPE Report.

Recommended Readings

Emmingham, W.H., and K. Maas. 1994. Survival and growth of conifers released in alder-dominated coastal riparian zones. COPE Report 7(2 & 3):13-15.

Tucker, G., W.H. Emmingham, and S. Johnston. 1993. Commercial thinning and underplanting to enhance structural diversity of young Douglas-fir stands in the Oregon Coast Range. COPE Report 6(2):2-4.

Kathleen Maas and W.H. Emmingham,
Adaptive COPE

WINTER PRECIPITATION SUMMARY: WATER YEAR 1994, OREGON COAST RANGE

For the past 5 years, Adaptive COPE has been involved in monitoring a network of 14 tipping bucket rain gauges. The network extends 60 miles from north to south, and 17 miles from east to west. A map of rain gauge locations and summaries of data from previous years has appeared in earlier issues of the COPE Report (see Recommended Readings). In this report, I summarize winter precipitation during the 1994 water year.

The total winter precipitation averaged for 14 gauging stations was 48.60 inches (Table 1). This was the driest winter recorded since the gauges were first installed in 1989.

The driest months were October with 2.03 inches and November with 4.80 inches. December and February were the wettest months with 13.42 inches and 11.39 inches respectively. The highest rainfall was recorded at gauge 1 with 64.60 inches, while gauge 16, commonly a zone of higher precipitation, was estimated to be 67.60 inches. We compared rainfall during WY 1994 with the previous 5 water years for the nine gauges active since 1989 (gauges 1-9) (Figure 1). November and January of WY 1994 were the driest on record. October of WY 1989 is the only October that had less rainfall than October of WY 1994.

Storms were typically of long duration and low intensity, with some variability between stations for any given storm. For example, from February 20 through February 24 no more than a 4-hour break in the rain occurred at the Deer Creek, Indian Creek, and Panther Creek stations (Figures 2A, 2B, and 2C). This storm lasted approximately 92 hours and the highest 1 hour intensity was 0.28 inches at both Deer and Panther Creeks. However the timing of intensity was quite different at each station, occurring around 12:30 pm on the 21st for Panther and around 6:00 am on the 24th at

Table 1. Precipitation summary for winter months of water year 1994. For specific locations of the precipitation stations, see Recommended Readings.

Station No.	Watershed	Oct	Nov	Dec	Jan	Feb	Mar	Total
		Precipitation (in.)						
1	Indian	2.04	4.52	18.84	13.36	15.56	10.28	64.60
^2	Thomson	2.28	4.03	14.15	10.42	11.59	8.50	50.97
3	Sweet	1.96	6.72	11.04	8.88	11.52	7.96	48.08
4	South	2.72	4.80	16.84	12.40	13.80	10.12	60.68
5	Smith	1.32	6.40	9.76	7.31*	9.00*	5.98*	33.79
6	Johnson	2.04	6.12	10.56	8.12	10.00	6.64	43.48
7	Wassen	1.80	5.88	9.72	7.08	8.24	6.20	38.92
8	Kirk	1.88	3.04	10.84	7.20	7.84	5.72	36.52
^9	Mill	1.97	3.19	11.38	7.56	8.23	6.01	38.35
11	Panther	1.88	4.32	15.60	10.80	12.32	8.48	53.40
12	Ryder	2.84	6.52	12.24	8.32	11.08	8.20	49.20
14	Lobster	1.52	3.00	13.20	7.44	10.00	6.52	41.68
15	Deer	2.04	4.00	14.12	10.04	14.04	9.31*	53.55
^16	Cascade	2.12	4.70	19.59	13.89	16.18	10.69	67.18
	Average	2.03	4.80	13.42	9.49	11.39	7.47	48.60
	St. Dev.	0.39	1.27	3.14	2.28	2.62	2.62	10.14
	C.V.	0.19	0.26	0.23	0.24	0.23	0.35	0.21

* = Estimated using correlation coefficients derived from linear regression.
^ = Equipment malfunction, whole station was estimated.

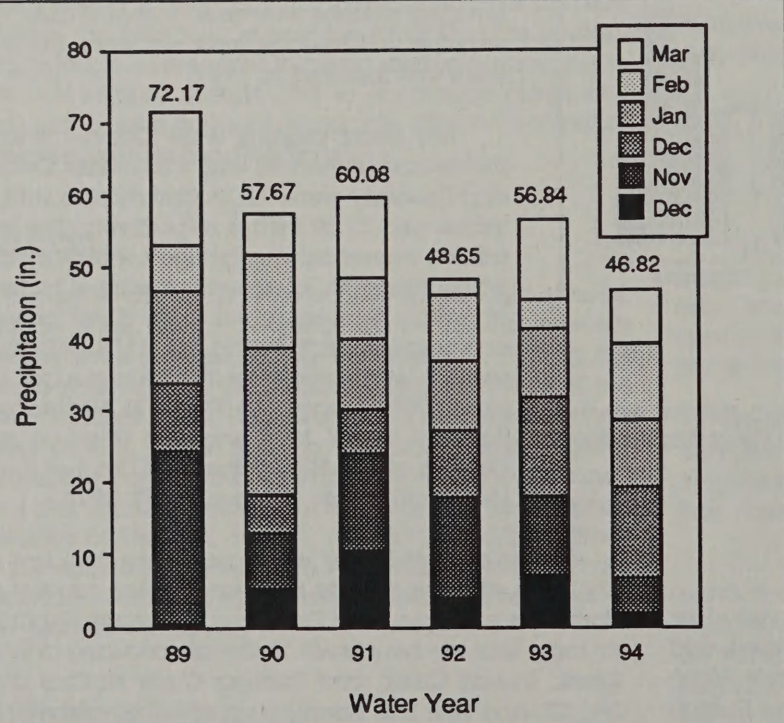

Figure 1. Average winter precipitation recorded for gauges 1-9 of the Oregon Coast Range precipitation gauge network, WY 1989 to WY 1994.

Deer Creek. The highest 1 hour intensity at Indian Creek was 0.20 inches. Total precipitation recorded was 7.2 inches at Deer, 6.4 inches at Indian, and 5.4 inches at Panther.

The rain gauge network continues to provide an important baseline of data to assess patterns of rainfall in the Oregon Coast Range. Data from the network will be used to monitor hydrological patterns in the Coast Range and will provide a tool to measure the influence of physical parameters on the region's biota.

Recommended Readings

Andrus, C. 1989. Summary of precipitation data for the first half of the 1989 water year. COPE Report 2(3):6-7.

Andrus, C. 1990. Summary of precipitation data for the second half of the 1989 water year. COPE Report 3(1):8.

Andrus, C., and H. Froehlich. 1989. Rainfall data now available for the central Coast Range. COPE Report 2(1):6.

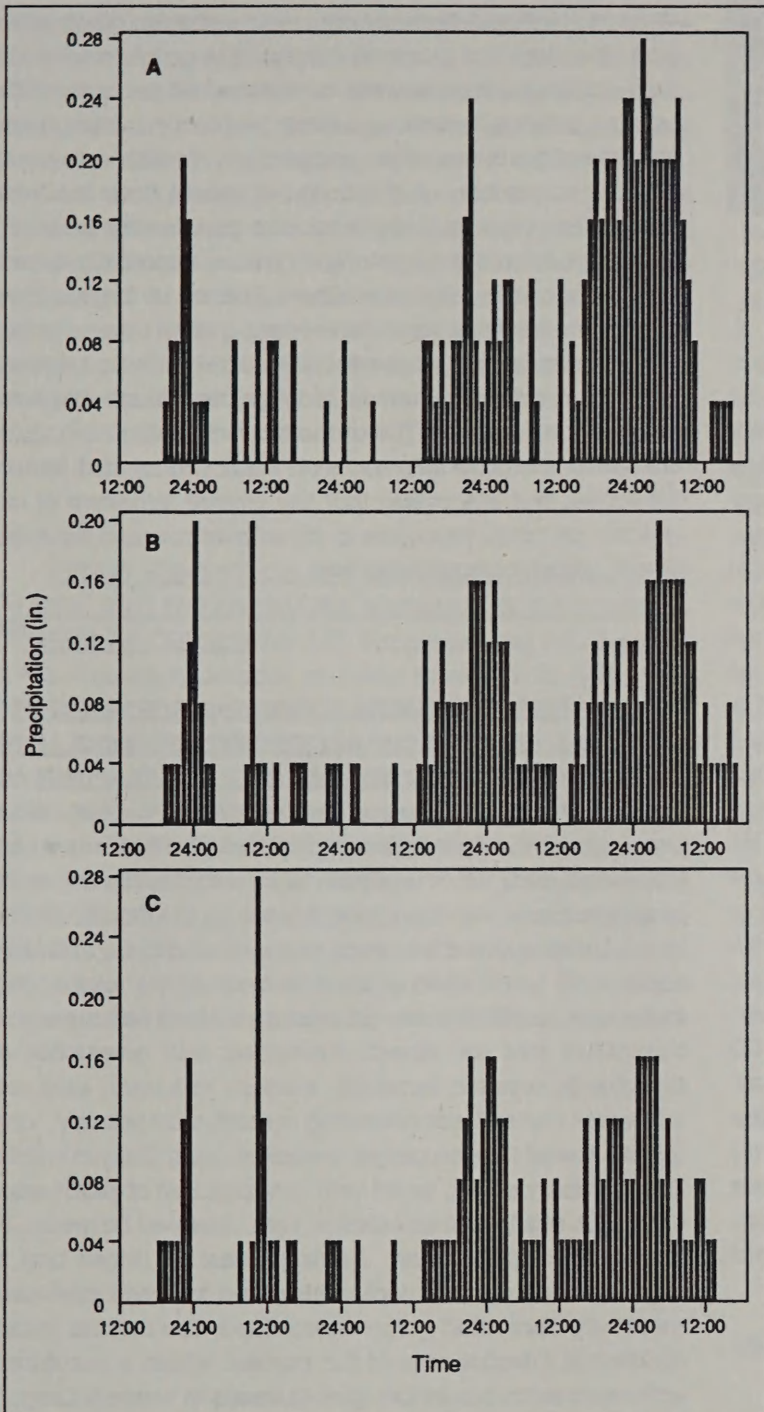

Figure 2. Hourly precipitation during the February 20 to 24, 1994 storm at three gauging stations: (A) Deer Creek (gauge 15), total rainfall 7.2 inches; (B) Indian Creek (gauge 1), total rainfall 6.4 inches; (C) Panther Creek (gauge 11), total rainfall 5.4 inches.

Dent, L. 1993. Summary of 1993 water year winter precipitation. COPE Report 6(3):2-4.

Lautz, K. 1991. Summary of precipitation for the first half of the 1991 water year. COPE Report 4(3):8.

Lautz, K. 1991. Summary of precipitation data for April-November 1990. COPE Report 3(4):10-11.

Lautz, K. 1992. Summary of precipitation data for the first half of the 1992 water year. COPE Report 5(3):3-5.

Liz Dent,
Adaptive COPE

OPPORTUNITIES

ECOLOGICAL RISK ASSESSMENT: USE, ABUSE & ALTERNATIVES

November 15-16, 1994 LaSells Stewart Center
Corvallis, OR

The purpose of this symposium is to explore the philosophical basis for the use of risk assessment in solving ecological problems. Not intended as a technical meeting presenting risk assessment methodology, but rather a debate about the usefulness of scientific risk assessment as a tool in the environmental arena.

The symposium will be of interest to sociologists, biologists, environmental groups, economists, policy-makers, and anyone interested in risk assessment as it applies to environmental issues.

ADVANCED VARIABLE PROBABILITY SAMPLING

November 16-18, 1994 OSU

This course is designed for those who use and collect stand inventory information. It is particularly well suited for those who have attended the Oregon State University Variable Plot and 3P Sampling short course.

This is a more in-depth coverage of sampling methods and analysis that will provide the opportunity to learn how to make better plans for collecting and using forest data.

For more information on the above conferences, contact College of Forestry Conference Office, Oregon State University, Peavy Hall 202, Corvallis, OR 97331-5707, or Telephone (503) 737-2329, or FAX (503) 737-2668.

PUBLICATION REVIEWS

WHAT IS ECOSYSTEM MANAGEMENT? by R. E. Grumbine. 1994. Conservation Biology 8:27-38. The term "ecosystem management" is widely used by scientists, resource managers, environmentalists, and industry representatives, but there are diverse interpretations of what is truly meant by the term. What the term "ecosystem management" means is more than an academic or semantic question; resolution of the question could affect the management of large acreages of forest land in the Pacific Northwest. The term has not been consistently used or applied by land management agencies, but, in this paper, Grumbine argues that a consensus is slowly emerging concerning what is meant by "ecosystem management." Grumbine reviewed several articles, books, and government documents to trace the development of the concept and to determine common themes expressed in writing on ecosystem management. He outlines ten dominant themes that are consistent with most current writings on the subject. Grumbine found that five management goals were frequently presented as fundamental to ecosystem management: (1) maintain viable populations of all native species, (2) represent all native ecosystem types across their natural range of variation, (3) maintain evolutionary and ecological processes, (4) manage over periods of time long enough to maintain the evolutionary potential of species and ecosystems, and (5) accommodate human use and occupancy within these constraints. Grumbine closes with a discussion of the short-term and long-term policy implications of a move toward ecosystem management.

JPH

UNGULATE-FOREST RELATIONSHIPS IN OLYMPIC NATIONAL PARK: RETROSPECTIVE EXCLOSURE STUDIES by A. Woodward, E.G. Schreiner, D.B. Houston, and B.B. Moorhead. 1994. Northwest Science 68:97-110. The relationship between ungulates and vegetation is a close one; ungulates are dependent on the quality and quantity of forage, and in turn, foraging by ungulates can have a dramatic influence on the abundance of plants and species composition of the vegetative community. In this paper, Woodward et al. infer the influence of ungulates on vegetative communities in the Olympic National Park by examining species composition and abundance of plants in a series of ungulate exclosures. Some of the exclosures were established 60 years ago. The authors provide instances where herbivory by ungulates influenced the composition, morphology, and standing crop of forest vegetation at all structural levels, from the forest floor to the overstory trees. Shrub size and density generally increased following ungulate exclusion, especially for salmonberry and huckleberry. The influence of ungulate exclusion on establishment of overstory species was variable; browsing impacted recruitment of Pacific silver fir and western red cedar, but the influence of ungulates on other species of trees was less clear. The authors conclude that ungulates can have dramatic influences on small spatial and temporal scales, but emphasize that the overall influence of ungulates on forest processes is sometimes masked by infrequent, large-scale disturbances.

JPH

RELATIONSHIP BETWEEN OCCURRENCES OF LAMINATED ROOT ROT AND SITE CHARACTERISTICS IN DOUGLAS-FIR FORESTS IN THE NORTHERN OREGON COAST RANGE by W.W. Kastner, D.J. Goheen, and R.L. Edwards. 1994. Western Journal of Applied Forestry 9(1):14-17. *Phellinus weirii*, laminated root rot is reported to be responsible for more damage than any other root disease in the Pacific Northwest. Locating infested areas is the first step in reducing losses to *P. weirii*. Kastner et al. examined the relationship between quantifiable site characteristics and occurrence of laminated root rot. Stands examined had overstories of Douglas-fir, western hemlock, western redcedar, and red alder and understories consisting of salal, salmonberry, vine maple, dwarf Oregon grape, swordfern, and Oregon oxalis. The occurrence of *P. weirii* was independent of plant association. A significant association was observed between *P. weirii* and slope position. Areas highest on ridges had a higher percentage of infected plots and infection rates progressively decreased going down slope. The authors found an overall infection rate of 5.6 percent which is consistent with other estimates for Douglas-fir forests in western Oregon and Washington.

KGM

RECOVERY OF DOUGLAS-FIR SEEDLINGS AND SAPLINGS WOUNDED DURING OVERSTORY REMOVAL by S.D. Tesch, K. Baker-Katz, E.J. Korpela, and J.W. Mann. 1993. Canadian Journal of Forest Research 23:1684-1694. Damage to advanced regeneration during silvicultural operations designed to promote structural diversity of stands is of concern.

This study examines damaged and undamaged Douglas-fir trees ranging in height from 15 to 450 cm for 6 years following overstory removal in forest stands in the Siskiyou and southern Oregon Cascades. Recovery of understory trees wounded during logging operations was evaluated. Natural and planted Douglas-fir can recover from wounds within 6 years on dry sites. Wounded, recently planted trees suffered the highest mortality. Lateral branches grew to replace broken terminal leaders or stems, bole wounds healed rapidly, and trees pushed over were able to return to an upright position. Trees with the poorest recovery had a combination of being pushed over to the ground and having a bole wound.

KGM

ESTABLISHMENT OF SALMONBERRY, SALAL, VINE MAPLE, AND BIGLEAF MAPLE SEEDLINGS IN THE COASTAL FORESTS OF OREGON by J.C. Tappeiner and J.C. Zasada. 1993. Canadian Journal of Forest Research 23:1775-1780. Hardwoods and shrubs are structurally important to coastal forest ecosystems and can prevent or delay conifer regeneration. Seed predation, emergence, survival, and growth of salmonberry, salal, vine maple, and bigleaf maple were studied on disturbed and undisturbed soil in thinned, unthinned, and clear-cut conifer stands. Emergence and survival of seedlings for all four species was greatest in thinned stands. Emergence of salmonberry and salal was highest on mineral soil while the presence of an organic layer on the seed bed had little or no effect on the establishment of vine maple and bigleaf maple. Seed predation was a factor in establishment of vine maple and bigleaf maple which have larger seeds than salal and salmonberry. Salal and salmonberry were not significantly affected by seed predation. Salmonberry growth was greater in clearcuts than thinned and unthinned stands. Vine maple and bigleaf maple growth was greatest in thinned stands and these species were more heavily browsed in clearcuts than in the other stands.

KGM

USE OF LOGS WITHIN HOME RANGES OF CALIFORNIA RED-BACKED VOLES ON A REMNANT OF FOREST by D. Tallmon and L.S. Mills. 1994. Journal of Mammalogy 75:97-101. The western (or California) red-backed vole has long been thought to be associated with fallen logs in the forests of western Oregon and northwestern California. Using radio-telemetry to track vole movements, Tallmon and Mills present the best data available to address the relationship between red-backed voles and logs. Tallmon and Mills successfully radio collared and followed four red-backed voles in this study. Of 134 locations, 131 (98 percent) of all locations were associated with logs despite the fact that logs only covered 7 percent of the home ranges of the animals. Tallmon and Mills found that voles were significantly associated with logs in later stages of decay. The authors argue that retention of logs in late stages of decay is essential to the persistence of this species.

JPH

COPE

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Errata 11/21/94

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Draft 9-8-94

Prospectus for

COASTAL LANDSCAPE ANALYSIS AND MODELING STUDY (CLAMS)

Our understanding of ecosystems is largely based on studies of small areas over short periods of time. While these studies have greatly advanced our scientific understanding of ecosystems, they are frequently conducted at scales that are inappropriate to understand the pattern and dynamics of large ecosystems. Large-scale ecosystem studies are needed because (1) many ecological processes such as long-term forest succession, population dynamics, disturbance, and environmental and land-use change operate over large areas for long periods of time, (2) human land use activities are widespread and their potential cumulative effects on biological diversity and ecosystem structure and processes can best be understood at aggregate levels, (3) many economic and social processes and land-use policies operate at the scale of counties, and states, and regions, and (4) policies by state and federal agencies and regulators are usually set over broad areas. Given that human activities have and are continuing to change the biosphere over large areas, it is imperative that we expand the scale and content of our concept of ecosystems to include large areas, long times, and wide spread human activity.

This prospectus briefly describes a COPE-funded research project that will study the Oregon Coast Range as a large ecosystem. The ecological and policy diversity of the Coast Range makes it well-suited for a study of a large multi-ownership ecosystem.

The study area contains a 5,000,000 acre physiographic province characterized by a highly productive forest ecosystems, distinctive biotic communities, and strong aquatic-terrestrial ecosystem linkages (Figure 1). Controversies over the protection of fish and wildlife species, including spotted owls, marbled murrelets, and dwindling fish stocks dominate much of the forest policy discussion. At the same time, the area is rich in the diversity of forest policies with over 2/3 of the forest acreage of the Coast Range in private ownership, much of it industry land, and the remaining forest almost equally split between Forest Service, Bureau of Land Management, and the State,

With the multitude of controversies on biodiveristy policy in the Coast Range, there is a need for methodologies for understanding large ecosystem patterns and interactions and for developing policies to maintain sensitive elements of biological diversity through an approach that is ecologically comprehensive and economically and socially efficient. CLAMS attempts to develop these methodologies through a multi-disciplinary research effort.

GOAL

Develop and evaluate concepts and tools to understand patterns and dynamics of large ecosystems such as the Coast Range and to analyze the economic and ecological consequences of different forest policies for these systems.

MAJOR OBJECTIVES

1. Characterize the pattern and dynamics of vegetation, habitat, and human activity in the Coast Range Physiographic Province.

2. Develop policy analysis tools including spatial data bases, spatial ecological change models, monitoring approaches, and ecological and economic effects models at the subregional/regional scale.

3. Compare and contrast alternative approaches to large (landscape to subregional level) ecosystem analysis and policy.

APPROACH

Remote sensing (Landsat) and other information will be used to create a map of current vegetation conditions and reconstruct change in relation to environment and ownership over the last 20 years. GIS layers will be developed for environmental factors and land ownership from existing data bases. Ground plots and aerial photographs will be used to estimate forest conditions within map units for characteristics that can not be detected with remote sensing, such as species composition, and live and dead stand structure.

Vegetation change resulting from disturbance and succession will be mapped and analyzed in relation to environment and ownership for the period 1972-1992. Ground sampling of vegetation and aerial photographs will be used to evaluate successional trends in part of the area and the effects of environment and land use on rates of late successional forest development. Aerial photographs and historical records will be used to characterize forest change over the last 20 -100 years. A separately-funded study at the University of Oregon will characterize vegetation change and fire history for the last 2,000-40,000 years.

A spatial vegetation/habitat dynamics model to project vegetation change over time will be developed. The model will incorporate different disturbance regimes ranging from those based on hypothesized long-term patterns of disturbance to those based on the pursuit of economic objectives. The intent is to create an ecologically-based harvest (disturbance) spatial scheduling model for the study area. The ability to accept spatially-based forest

GOAL

Develop and evaluate concepts and tools to understand patterns and dynamics of [illegible] in the Coast Range and to analyze the economic and ecological consequences of different forest policies for these systems.

MAJOR OBJECTIVES

1. Characterize the pattern and dynamics of vegetation, habitat, and human activity in the Coast Range Physiographic Province.

2. Develop policy analysis tools including spatial data bases, spatial ecological change models, monitoring approaches, and ecological and economic effects models at the subregional/regional scale.

3. Compare and contrast alternative approaches to large (landscape to subregional level) ecosystem management policy.

APPROACH

Remote sensing (Landsat) and other information will be used to create a map of current vegetation conditions and reconstruct change in relation to environment and ownership over the last 20 years. GIS layers will be developed for environmental factors and land ownership from existing data bases. Ground plots and aerial photographs will be used to estimate forest conditions within map units for characteristics that can not be detected with remote sensing, such as species composition, and live and dead stand structure.

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A spatial vegetation/habitat dynamics model to project vegetation change over time will be developed. The model will incorporate different disturbance regimes ranging from those based on hypothesized long-term patterns of disturbance to those based on the pursuit of economic objectives. The aim is to create an ecologically-based harvest (disturbance) spatial scheduling model for the study area. The ability to accept spatially-based forest

policies for public and private owners will be an important feature of the simulation structure as will the ability to accept different models of landowner behavior.

Wildlife, fish, and economic models will be developed (or existing models adapted) that will use the results of the vegetation dynamics models to evaluate biological and economic effects of vegetation changes, spatial patterns, and dynamics at the scale of a province. Models will take different forms depending on the discipline and the current knowledge base. In most cases the biological models will be simple correlative models based on habitat conditions. At least one demographic process model will be used in the wildlife analysis. Estimates of the protection of fish and wildlife species given by underlying habitat conditions will be done through risk analysis. Risk analysis methodologies will be evaluated.

Economic/management models will be developed to estimate province-level economic outputs from commercial timber harvest, special forest products, and recreation (including recreational fishing) and tourism. Potential economic effects on the commercial fishing industry will also be considered.

These ecological, economic, and social models will be linked to the vegetative change simulator to enable evaluation of the efficiency of different forest policies in providing specified levels of protection for fish, wildlife, and ecosystem processes. A representative set of alternative policy scenarios will then be analyzed to test the usefulness and robustness of the data, models, and methodologies developed in the study.

AUDIENCE

The results of CLAMS should be useful to the state and federal regulatory boards, including the State Board of Forestry, National Marine Fisheries, and US Fish and Wildlife, in evaluating the effect of potential forest and water policies for the Coast Range. It should be useful to federal land managers, including the BLM and Forest Service, as they attempt to undertake watershed analysis, provincial planning and ecosystem management as prescribed in the President's Plan. It should also be useful to the State of Oregon as they replan the management of the State Forests of the Coast Range.

Federal land managers will be able to use the tools and information to help with implementation of the President's plan as it applies to federal lands. For example, the research will attempt to find ecologically and socio-economically efficient approaches to meeting the purpose and needs of the standards and guidelines which are "to take an ecosystem approach to forest management; maintain and restore biological diversity as it applies to late-successional and old-growth forest ecosytems". The research will develop integrated spatial ecosystem models for comparing alternative approaches to watershed

analysis, province-level planning and monitoring, and cost-benefit analysis of restoration activities. The data bases and analysis tools will also be useful to the Adaptive Managment Areas to help meet their objective of developing "new approaches to land management that integrate economic and ecological objectives..".

Private landowners should find the results of CLAMS useful in helping them understand the implications of suggested forest polices for the Coast Range and in providing a vehicle for trying out their ideas on different protection policies for fish and wildlife. Processors of timber products should be able to better judge the likely timber harvest under existing and future forest policies.

Coastal communities, counties, and others should be able to use the information and models from Clams to more accurately understand the ecological, economic, and social implications of existing and proposed forest policies. Also, interest groups and interested citizens should similarly find this information of use.

Scientists should be able to use the data, methodologies, and models to study fundamental questions about conservation biology, landscape ecology, ecosystem management, and the relationship between ecological and socio-economic conditions.

JUSTIFICATION FOR CLAMS IN THE PRESIDENT'S PLAN FOR FEDERAL LANDS

CLAMS applies to many needs and requirements of the President's Plan for Federal lands including the following:

1. An integrated ecosystem basis for province and multi-province level planning among "federal agencies, states, American Indian tribes and others".

2. Watershed analysis and monitoring across spatial scales and ownerships.

3. Data bases and spatial analysis tools for Adaptive Management Areas.

4. Approaches integrating ecological and socio-economic perspectives.

5. Ecologically, adminstratively, and socio-economically efficient ways to implement the plan for maintenance of biological diversity.

REVIEWERS

We plan to seek ongoing review of the policy models and methods from federal and state land managers and regulators, private landowners, and other interested people. The COPE advisory council will be involved in the development of representative scenarios to test models. We will obtain scientific peer review of the research plan and study results from a variety of outside reviewers.

EXAMPLES OF MAJOR PRODUCTS

Ecological, Economic, and Social Information:

- Relationships between patterns of forest vegetation and environment and land use.
- Rates of disturbance and forest succession in relation to environment and land use.
- Comparisons of current vegetation with estimates of vegetation from other historical periods from 150 to 10,000 years ago.
- Pattern and changes in wildlife and fish habitat across watersheds and ecological subregions.
- Pattern and change in the location of economic and social activity.

Policy Analysis Tools

- Multi-owner, and multi-temporal spatial ecological data bases.
- Development and evaluation of monitoring approaches at watershed and subregional scales.
- Models to predict investment and harvest behavior under different policies.
- A spatial vegetation/habitat change model.
- Approaches to finding feasible and efficient solutions to harvest scheduling under different spatial policies.
- Approaches and models to evaluate effects of vegetation change and forest policy at

the province level on wildlife, fish, economic outputs, and social well-being.

Policy Evaluation and Understanding

- Overall methodology and data set for evaluating forest policies for the Coast Range.
- Test of this methodology and data set on representative policies
- Evaluation of feasibility of conducting multidisciplinary analysis at the scale of a physiographic scale
- Limitations on the types of policy analysis that can be done at the provincial level and suggested linkages to policy formulation at higher and lower scales.

PRINCIPAL INVESTIGATORS AND MAJOR RESPONSIBILITIES

Thomas A. Spies (PNW). Co-leader. Vegetation pattern and change analysis. Ecosystem dynamics approaches. Scenario development.

K.Norman Johnson (OSU). Co-leader. Economic and policy analysis. Scenario development. Timber use history. Risk analysis. Linkage with other planning groups.

Warren Cohen (PNW) Remote sensing and GIS data base development. Stand and polygon definition. Landscape monitoring research. Forest change analysis.

Steve Garman (OSU). Wildlife analysis and spatial modeling.

Becky Johnson (OSU). Aggregate economic effects. Recreation and tourism.

William McComb (OSU). Wildlife habitat analysis. Population viability analysis.

Joe Means (PNW) Vegetation change rules and model structure. Growth and yield modelling.

Gordon Reeves (PNW). Fish habitat and watershed analysis.

John Sessions (OSU). Timber inventory analysis. Vegetative modeling on a landscape scale. Efficient timber harvest, investment, and roading strategies under different spatial policies.

COOPERATORS

Dave Cleaves (SO). Human Behavior, Risk Analysis.

Micheal Collopy (NBS). Marbled murrelet habitat

Martin Raphael (PNW) Spotted Owl habitat and viability analysis.

James Sedell (PNW) Watershed Analysis.

Fred Swanson (PNW) Watershed analysis, landscape dynamics, links with Cascade Center research.

John Tappeiner (NBS). Silviculture.

OTHER RESEARCH PERSONNEL

Xan Augerot (Ph.D. Student). Road and watershed analysis

Kevin Boston (Ph.D. Student). Landscape models

Jonathan Brooks (MS. Student). Avian habitat models

Kelly Burnett (Ph.D. Student). Watershed analysis and fish habitat

Barbara Marks (Senior Research Assistant). Programing/Modeling

Barbara Schrader (Ph.D. Student). Hemlock dynamics

Scott Splean (Research Assistant). GIS/Remote Sensing

Trevor Stone (Ph.D. Student). Economic models

DURATION OF PROJECT: FY 93-FY96

FOR FURTHER INFORMATION CONTACT Tom Spies, Forestry Sciences Lab, Corvallis, OR 97331. 503-750-7354, Norm Johnson, College of Forestry, Oregon State University, Corvallis, OR 97331 503-737-2377.

CLAMS Proposed Study Area

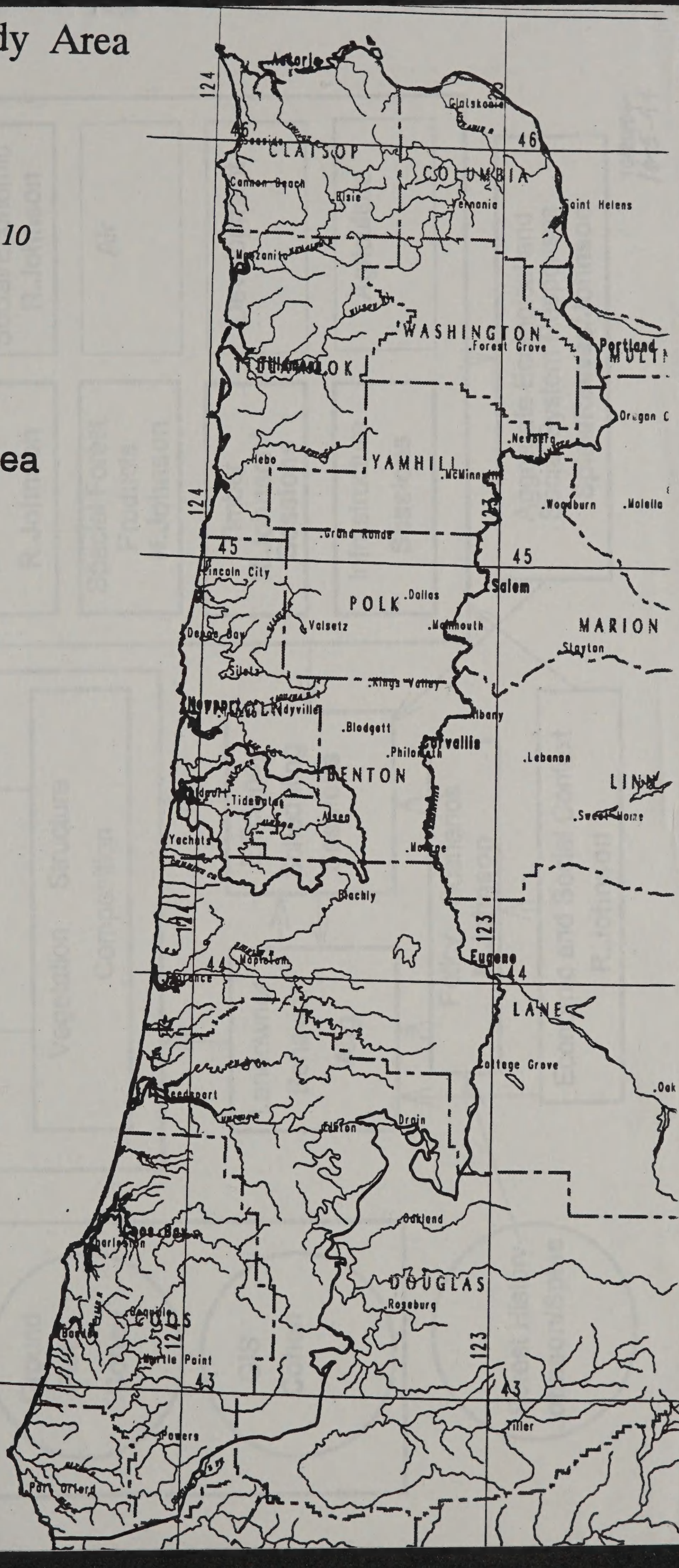
Scale 1:1,500,000

0 50
KILOMETERS

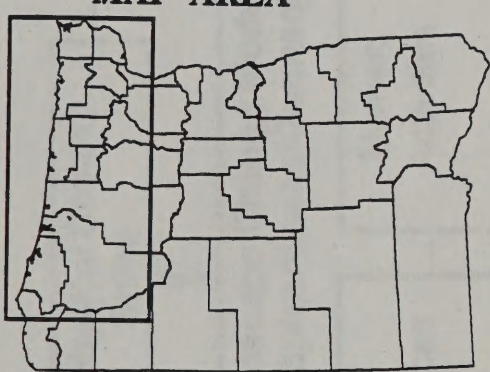
Projection: UTM - Zone 10

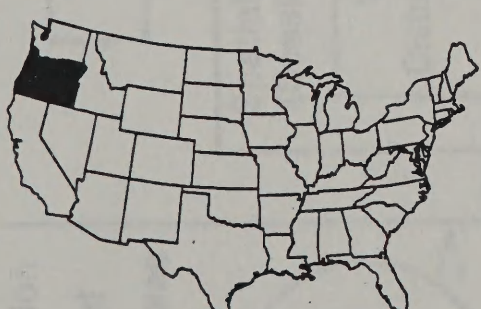
LEGEND

- Proposed Study Area
- Major Streams
- Alsea River Basin
- County Boundary



MAP AREA





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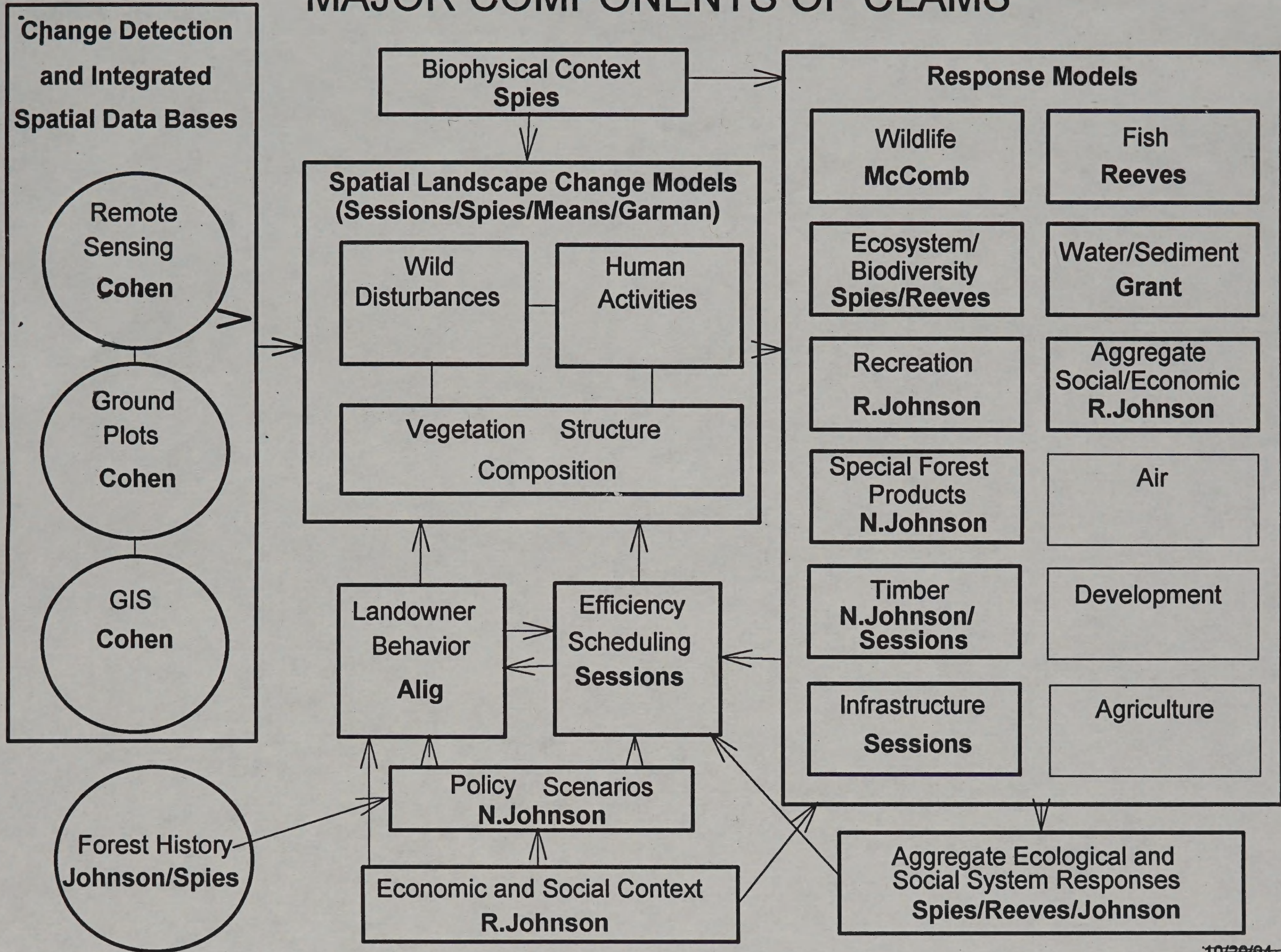
CARTOGRAPHY: Scott Spleen

GIS/Remote Sensing
C F S L

MAJOR COMPONENTS OF CLAMS



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